

Investigating Formative Assessment:
Exploring the Impact on the Self-Efficacy and Motivation of Mathematics Students

Assuntina Marietta Del Gobbo, B.Sc., B.Ed.

Department of Graduate and Undergraduate
Studies in Education

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Faculty of Education, Brock University
St. Catharines, Ontario

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Abstract

This is a study of the implementation and impact of formative assessment strategies on the motivation and self-efficacy of secondary school mathematics students. An explanatory sequential mixed methods design was implemented where quantitative and qualitative data were collected and analyzed sequentially in 2 different phases. The first phase involved quantitative data from student questionnaires and the second phase involved qualitative data from individual student and teacher interviews. The findings of the study suggest that formative assessment is implemented in practice in diverse ways and is a process where the strategies are interconnected. Teachers experience difficulty in incorporating peer and self-assessment and perceive a need for exemplars. Key factors described as influencing implementation include teaching philosophies, interpretation of ministry documents, teachers' experiences, leadership in administration and department, teacher collaboration, misconceptions of teachers, and student understanding of formative assessment. Findings suggest that overall, formative assessment positively impacts student motivation and self-efficacy, because feedback is provided which offers encouragement and recognition by highlighting the progress that has been made and what steps need to be taken to improve. However, students are impacted differently with some considerations including how students perceive mistakes and if they fear judgement. Additionally, the impact of formative assessment is influenced by the connection between self-efficacy and motivation, namely how well a student is doing is a source of both concepts.

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CHAPTER ONE: INTRODUCTION

Stiggins (2007) calls for a new vision of assessment within the classroom: one that fosters confidence, motivation, and learning among all students. In this study, I explored the implementation of formative assessment and its potential in fulfilling the vision put forth by Stiggins. Specifically, this study explored the impact of formative assessment strategies on student motivation and self-efficacy within the secondary school mathematics classroom.

Background

Within the Ontario Ministry of Education (2004) report on mathematical literacy, it is stated that:

Too often, society has accepted the stereotype that mathematics is for the few, not the many. The reality is that mathematics is deeply embedded in the modern workplace and in everyday life. It is time to dispel the myth that mathematics is for some and to demand mathematics success for all. (p. 9)

This statement alludes to the societal belief that success with mathematics is limited to those with an innate ability. This misconception reinforces students' negative self-perceptions about mathematics, particularly those who are low achievers. Furthermore, this misconception may make it appear as though it is acceptable for students and adults to self-identify as not being good at mathematics. This notion of it being acceptable to identify oneself as not being good at math is commonly apparent in the media. For example, in an appearance on the game show *Who Wants to be a Millionaire*, actress Patricia Heaton stated, "I am so bad at math...I can't do the math" (Bumgarner & Cohen, 2009). Another example is Mattel Inc.'s 1990s' release of the Teen Talk Barbie, which

made the statements, “I love shopping” and “math class is tough!” (McCarty, 1993). With these portrayals of attitudes towards mathematics occurring commonly in the media, it is not surprising that this misconception of mathematics being only for those with an innate ability continues to be perpetuated.

Within my experiences as a student, classroom volunteer for many years, teacher candidate, and most recently teacher, I have observed a decline in student motivation to pursue mathematics coupled with a decrease in students’ confidence in their ability to succeed at mathematics as they progress through secondary school education. *The Report of the Expert Panel on Student Success in Ontario* on mathematical literacy called for Ontario schools to be “re-cultured to reflect the principle that all students can become mathematically literate” (Ontario Ministry of Education, 2004, p. 50). In order for this to be possible, one recommendation that the report calls for is a shift in the way assessment is perceived, which includes a focus on assessment for the purpose of improving learning. It is this shift in the focus of assessment, combined with my experiences in mathematics classrooms, that has led me to explore the impact of formative assessment strategies on student motivation and self-efficacy in secondary school mathematics.

The assessment culture of the Ontario secondary school mathematics classroom is framed within various educational policies. The most recently released policy document on assessment, entitled *Growing Success: Assessment, Evaluation and Reporting in Ontario Schools*, emphasizes that the primary purpose of assessment is to improve student learning (Ontario Ministry of Education, 2010). This message is also explicitly stated within the Ontario secondary school mathematics curricula (Ontario Ministry of Education, 2005, 2007). In light of the assessment and evaluation policy document,

school goals commonly focus on improving student learning while maintaining high standards (Volante & Beckett, 2011). As Suurtamm, Koch, and Arden (2010) state, Ontario is an example where mathematics curricula and teacher resources demonstrate reformed views of assessment that:

Have shifted from a view of assessment as a series of events that objectively measure the acquisition of knowledge toward a view of assessment as a social practice that provides continual insights and information to support student learning and influence teaching practice. (p. 400)

The coherent messages among ministry documents, coupled with research that indicates that the use of formative assessment can improve learning, emphasize the importance of implementing formative assessment practices with the goal of improving learning (Black, Harrison, Lee, Marshall, & Wiliam, 2004; Black & Wiliam, 1998a).

Statement of the Problem

The focus of this research was on secondary school mathematics students' motivation and self-efficacy. The research problem that prompted this study was rooted in two issues. The first issue is the critical impact that assessment results have on student motivation and self-efficacy. Students' perceptions of their capabilities as learners and their willingness to continue trying to learn are influenced by assessment results (Stiggins, 2005, 2010). When students frequently perform poorly on assessments, they lose confidence in themselves as learners and lose motivation to continue trying to learn the subject (Stiggins, 2007). This is problematic because student self-efficacy and motivation are important factors for student learning and achievement (Nasiriyani, Azar, Noruzy, & Dalvand, 2011; Zientek & Thompson, 2010). As Stiggins (2005) states, "the

entire emotional environment surrounding the prospect of being evaluated must change, especially for perennial low achievers” (p. 326).

The second issue prompting this study is that despite the abundance of literature on the benefits of formative assessment (see Black et al., 2004; Black & Wiliam, 1998a, 1998b), there still exists a need to connect research on formative assessment with classroom practices (McMillan et al., 2010; Volante & Beckett, 2011). These two issues point to the need to investigate the impact of formative assessment on student self-efficacy and motivation. Consequently, this study explored how formative assessment strategies can contribute to the development of improved self-efficacy and motivation among secondary school mathematics students. This study focused on the implementation of formative assessment within the context of secondary school mathematics classrooms.

Purpose of the Study

The purpose of this study was twofold. First, the study aimed to explore the impact of formative assessment strategies on secondary school mathematics student motivation and self-efficacy. Second, the study explored how formative assessment strategies are implemented within the context of a secondary school mathematics classroom. As outlined by Black et al. (2004), formative assessment strategies include questioning techniques, feedback without grades, self-assessment, peer assessment, and the formative use of summative assessments. This research investigated these issues from the perspective of two groups of stakeholders; namely, teachers and students.

Research Questions

This study was guided by the following question: In what ways does the implementation of formative assessment practices impact the self-efficacy and motivation of secondary school mathematics students? Specifically, this study considered the following questions:

1. In what ways is formative assessment implemented within the secondary school mathematics classroom?
2. What are the perceptions of the impact of formative assessment strategies on student self-efficacy and motivation in mathematics?

Rationale

With an increasing demand for the primary purpose of assessment to be improvement of learning, the role of formative assessment within the classroom is of growing importance. As Black and Wiliam (2004) state, formative assessment can be considered the “heart of effective teaching” (p. 140). Despite this, there still exists a need to connect research on formative assessment and classroom practices (McMillan et al., 2010; Volante & Beckett, 2011). Consequently, it is necessary to learn from teachers who are implementing formative assessment strategies within the Canadian context and, more specifically, the Ontario context. What specific formative assessment strategies do teachers use in their classrooms, how have these strategies impacted students’ motivation to pursue mathematics, and how have these strategies impacted the development of students’ self-efficacy in mathematics?

Stiggins (2002) proposed the question, “can we design ... assessment systems that have the effect of helping our students want to learn and feel able to learn?” (p. 2). This

question reflects the need to implement assessment strategies that foster motivation and self-efficacy. Although research examining the impact of formative assessment strategies on student learning is abundant, research focusing on its impact on student motivation and self-efficacy, specifically at the secondary school level, remains limited. This research will contribute to addressing this gap in the literature by focusing on secondary school mathematics students. In addition, studies that include students' perspectives are limited (Kirton, Hallam, Peffers, Robertson, & Stobart, 2007; Miller & Lavin, 2007). Students' perceptions are important because, as Ames (1992) discusses, "to predict and examine motivated cognitions, affect, and behaviour of a student, it is necessary to attend to how that student perceives and gives meaning to classroom experiences" (pp. 267-268). Moreover, studies on assessment that have included the perceptions of students (e.g. McMillan & Turner, 2014; Peterson & Irving, 2008) have not focused on all the formative assessment strategies. This study will also contribute to the research on formative assessment by focusing on students' perceptions of their own learning experiences.

Theoretical Framework

This research was founded on the premise that student motivation and self-efficacy are important aspects of an effective learning environment. This premise is informed by two conceptual frameworks. The first framework is based on Bandura's (1977, 1989, 1994) social cognitive theory on self-efficacy, which holds that self-efficacy beliefs influence how one feels, thinks, behaves, and is motivated. The second framework is based on the achievement goal theory, also known as goal orientation theory, which conceptualizes motivation through the types of goals that one pursues when in a situation

involving achievement (Meece, Anderman, & Anderman, 2006). Self-efficacy theory and the achievement goal theory were used as a framework for this study in order to investigate the impact of formative assessment strategies on student self-efficacy and motivation in mathematics.

Self-Efficacy

According to Bandura (1977, 1989, 1994), self-efficacy is a belief in one's competence and ability to successfully complete a task. In social cognitive theory, human functioning is based on intrapersonal influences, the environment, and behaviours in which individuals take part (Bandura, 2012). Since self-efficacy is part of the intrapersonal influences that impact human functioning, individuals influence events and the path of their lives. Social cognitive theory is founded on this agentic perspective, which holds that individuals have influence over their own functioning and the events in their life through the actions they take (Bandura, 2012).

A person's self-efficacy expectations are based on four major sources including performance accomplishments, vicarious experience, verbal persuasion, and emotional arousal (Bandura, 1977). Performance accomplishments are an influential source of self-efficacy because they are based on personal mastery experiences (Bandura, 1977). In order to develop resilient self-efficacy, a learner must have experiences in overcoming obstacles through perseverance. Furthermore, it is necessary that learners are able to deal with failure by using the experience as a learning opportunity rather than being demoralized (Bandura, 2012).

The second source of a person's self-efficacy expectations, vicarious experience, involves observing others perform activities and taking note of the resulting

consequences (Bandura, 1977). In observing others similar to oneself succeed by investing effort, an individual is able to believe that he or she also has the ability to succeed in a similar situation. Conversely, observing others fail despite investing effort decreases a learner's self-efficacy and motivation to invest effort in a similar situation (Bandura, 1994).

Verbal persuasion, the third source of a person's self-efficacy expectations, encompasses the messages conveyed by others, which influences one's self-efficacy. Positive self-efficacy can be fostered through verbal persuasion that involves encouraging learners to determine success by self-improvement rather than by comparing themselves to others (Bandura, 2012).

The last source of a person's self-efficacy expectation is emotional arousal and involves the stress and anxiety elicited in a given task (Bandura, 1977). The way individuals interpret their physical and emotional states influences how they perceive their self-efficacy. As a result, self-efficacy can be improved by reducing anxiety and depression, developing physical strength, and learning to correctly interpret physical and emotion states (Bandura, 2012).

How an individual feels, thinks, behaves, and is motivated is impacted by his or her self-efficacy beliefs (Bandura, 1994). Self-efficacy beliefs act as a determinant of behaviour by influencing whether a person will participate in a task, the amount of effort invested, and how long one will persevere when faced with obstacles (Bandura, 1977). As a result, when students have high self-efficacy, challenging tasks will not be seen as something to be avoided, but rather as a challenge to be mastered (Bandura, 1994). Self-efficacy is a determinant of motivation because a person's self-efficacy impacts how

much effort is invested when faced with a challenge and how long he or she will persevere (Bandura, 1989). Within the context of education, students' self-efficacy influences their interest, academic achievement, and their aspirations (Bandura, 1994). For example, students with a high sense of self-efficacy will be more interested in their academic activities, set challenging goals, and be committed to the goals they set. In contrast, students with low self-efficacy will have low aspirations. When faced with a difficult task, they will focus on their deficiencies and have a weak commitment to persevere.

It should be noted that according to Bandura (1997), self-efficacy differs from the term confidence in that, "confidence is a nondescript term that refers to strength of belief but does not necessarily specify what the certainty is about" (p. 382). A person can be confident that he or she will be successful or confident that he or she will fail at a task. In contrast, the construct of self-efficacy is a belief in one's ability to successfully complete a task (Bandura, 1977, 1989, 1994, 1997). As a result, "a self-efficacy assessment, therefore, includes both an affirmation of a capability level and the strength of that belief" (Bandura, 1997, p. 382).

The four major sources of a person's self-efficacy expectations as well as the influence of a person's self-efficacy beliefs on his or her motivation are important aspects of the theoretical framework for this study.

Motivation

Achievement goal theory focuses on "students' intentions or reasons for engaging, choosing, and persisting at different learning activities" (Meece et al., 2006, p. 490). Goal theory falls within the social-cognitive view of motivation as "it recognizes

and emphasizes the reciprocal influences of personal and environmental factors on goal endorsement, and underscores the importance of perception” (Maehr & Zusho, 2009, p. 81). In contrast to other goal constructs, achievement goal theory places emphasis on understanding why individuals are trying to achieve, rather than on what they are trying to achieve (Maehr & Zusho, 2009). Student motivation is increasingly being recognized as a process that is influenced by the instruction, tasks, and activities that occur in the classroom (Maehr & Zusho, 2009). Achievement goal theory has played an important role in understanding the influence of classroom structures and school environments on student motivation and learning (Meece et al., 2006).

As Maehr and Zusho (2009) explain, there are two main perspectives of achievement goal theory: the traditional/normative perspective and the revised/multiple goals perspective. The traditional goal perspective, as reflected in the work of Ames (Ames, 1992; Ames & Archer, 1988), Dweck (Dweck & Leggett, 1988; Elliot & Dweck, 1988), Maehr (Maehr & Midgley, 1991), and Nicholls (1984), will be employed for the theoretical framework of this study. From this perspective, the two goal orientations are mastery and performance, which are contrasting approaches to motivation (Meece et al., 2006). The two orientations represent different perspectives of success and reasons for engaging in achievement activity (Ames, 1992; Nicholls, 1984).

A mastery goal orientation, also referred to as task-involved orientation, places emphasis on “learning, understanding, improving, mastering new skills, and taking on challenges” (Cauley & McMillan, 2010, p. 3). Success from a mastery goal orientation is based on one’s own progress (Meece et al., 2006). A student with a mastery-goal orientation would perceive competence “incrementally in reference to self-set standards

of excellence” (Maehr & Zusho, 2009, p. 80). The process of learning is valued and effort is perceived as important for success (Ames & Archer, 1988).

In contrast, a performance goal orientation, also referred to as ego-involved orientation, “represents a focus on demonstrating high ability relative to others, striving to be better than others, and using social comparison standards to make judgments of ability and performance” (Meece et al., 2006, p. 490). Success from a performance goal orientation comes from meeting normative performance standards (Ames & Archer, 1988; Meece et al., 2006). Ability is demonstrated by being successful, by performing better than others, or by being successful with little effort (Ames & Archer, 1988). A student with a performance goal orientation perceives competence “as a characteristic of the privileged few; thus being able to demonstrate that one has competence indicates that one is more able than others” (Maehr & Zusho, 2009, p. 80). In addition to seeking positive judgments of ability, this goal orientation is also associated with avoiding appearing incompetent (Elliott & Dweck, 1988; Pajares, 2006).

Ames and Archer (1988) found that when students perceived an emphasis on mastery goals within their classrooms, they were more likely to report using adaptive learning strategies, pursue challenging tasks, have a positive attitude towards the class, and associate success with effort. Students who perceived an emphasis on performance goals in the classroom focused more on ability, were more likely to negatively evaluate their ability, and attributed failure to a lack of ability (Ames & Archer, 1988). Meece et al. (2006) suggest that teachers can promote the development of a mastery orientation among students when they focus on skill development, mastery, and improvement. Furthermore, this orientation is fostered when evaluation methods are varied, evaluations

are private, mistakes are treated as part of the learning process, and students are provided with opportunities to improve (Ames, 1992; Cauley & McMillan, 2010). In contrast, a performance orientation is promoted when teachers attribute performance to individual ability, evaluations are made public, social comparisons are encouraged, and students are rewarded who perform better than others (Ames, 1992; Cauley & McMillan, 2010; Meece et al., 2006). As Ames (1992) states, “enhancing motivation means enhancing children’s valuing of effort and a commitment to effort-based strategies through the design of mastery-orientated classroom structures” (p. 268).

A focus on mastery goals has been associated with positive academic results (Ames, 1992; Meece et al., 2006) and has also been linked to greater cognitive engagement in comparison to a focus on performance goals (Meece, Blumenfeld, & Hoyle, 1988). Furthermore, a mastery goal orientation has been related to positive academic self-efficacy (Pajares, 2006; Roeser, Midgley, & Urdan, 1996). A mastery goal orientation has been associated with attributing success to effort rather than ability, persisting longer when faced with difficulty, and a preference for challenging work and risk taking (Ames & Archer, 1988; Elliott & Dweck, 1988; Pajares 2006). In contrast, a performance goal orientation is associated with avoiding challenging tasks (Dweck & Leggett, 1988; Elliott & Dweck, 1988), avoiding help seeking, and attributing failure to lack of ability (Pajares, 2006). Moreover, from a mastery orientation, mistakes are considered a part of the learning process, whereas from a performance orientation, mistakes are viewed as anxiety provoking (Ames & Archer, 1988).

The two conceptual frameworks of self-efficacy and motivation framed this study.

This theoretical framework guided the data collection, data analysis, and interpretation of results.

Importance of the Study

As stated within the Ontario Ministry of Education (2004) report, “one of the chief elements of mathematics education reform is teachers who make the development of student self-confidence in mathematics as important as achievement” (p. 26). This notion, combined with a vision of assessment practices that foster confidence, motivation, and learning among students, underlines the importance of this study (Stiggins, 2007). This research provides insight on the impact of formative assessment strategies on the self-efficacy and motivation of secondary school mathematics students. This insight has important implications for educators by enhancing teachers’ understanding of students’ perceptions of formative assessment practices. As a result, teachers gain a greater understanding of what assessment practices will improve student motivation and self-efficacy and, ultimately, academic achievement in mathematics. Furthermore, this study has implications for policy developers within the province. When determining best assessment practices to benefit Ontario students, having an understanding of the assessment culture from the perspective of students can enhance policy development.

Scope and Limitations of the Study

Conducted at a school board in southern Ontario, this study involved secondary school mathematics teachers and students. The data were collected in the second semester of the 2012-2013 academic year using survey questionnaires and semistructured interviews.

Limitations

This study is limited by some boundaries. This study was conducted in two schools in one district school board in southern Ontario. Because the purpose of this study was to explore the impact of formative assessment strategies, a purposeful sample was required to select classrooms in which the teacher was implementing formative assessment strategies. Although the results of this study provide insights on the impact of formative assessment on student self-efficacy and motivation, the results cannot be generalized to other contexts.

Furthermore, this study is limited by the number of teacher participants in the study. This study included two mathematics teachers from two different schools. Because a focus of the study was to gain the perspective of students, this limitation was minimized through the use of student participants from two classes for each teacher. This provided an adequate sample of student participants in order to explore students' perceptions of the impact of formative assessment practices.

The grade levels of student participants may also be considered a limitation of this study. Secondary school has four grade levels, within which exist several variations, including academic, applied, college, university, and mixed courses. Student participants were in Grades 9, 10, and 12 with one student who was in Grade 11, but taking a Grade 12 course. Because student participants had to be in the classes taught by the teacher participants, this study was bounded by the courses these teachers were teaching during the period of data collection. However, I do believe that a considerable variety of grade levels and courses were involved in this study. Moreover, teacher participants were able

to address the implementation and impact of formative assessment in other courses based on their teaching experience.

Another limitation existed with the possible inaccuracies of self-reported data of the participants. In order to address this limitation and encourage participants to provide accurate and honest responses, pseudonyms were assigned to reassure the participants of the anonymity of their responses. In addition, the names of the schools and the corresponding school board are not identified. Furthermore, student participants were notified that to further ensure their anonymity, only aggregate study results would be provided to teachers and school boards and only after the study was completed. The results were provided during an academic year different than the year the study was conducted.

A potential limitation of this study is that gender differences among student participants were not examined. Gender could possibly affect the impact of formative assessment strategies. An attempt to minimize this limitation was done by selecting an equivalent number of male and female students at each school to participate in the interviews.

Organization of the Document

In this chapter, the background and rationale that led to this study are presented. Furthermore, the problem this study aimed to address, the purpose of the study, and the research questions that were used to frame this study are discussed. Bandura's (1977, 1989, 1994) social cognitive theory on self-efficacy and achievement goal theory were outlined as the conceptual frameworks used to analyze and discuss the findings of the

study. In addition, the scope and limitations of the study were revealed in order to illustrate the boundaries of this study.

Chapter 2 outlines a review of the literature by addressing topics relevant to the purpose of this study and the research questions. The first part of the literature review presents different definitions of formative assessment and outlines which interpretation was used for the purpose of this study. Following this, the literature review addresses the impact of formative assessment strategies on student learning and on student self-efficacy and motivation in mathematics. The final sections of Chapter 2 provide a discussion of this impact specifically within mathematics classrooms and then within the Ontario context.

Chapter 3 presents the research design and data collection methods that were used to address the purpose and answer the research questions of this study. This chapter first provides a description of the explanatory sequential mixed methods design that was employed for this research study. The chapter then provides an explanation of how the sites and participants were selected and a description of the instruments that were used to collect data, namely, the survey questionnaire and the interview guides. The procedures involved in data collection are then outlined, followed by an explanation of how data were analyzed. The chapter then presents the methodological assumptions and limitations of this research and how the credibility of this study was established. Lastly, the ethical considerations that were taken into account are addressed.

Chapter 4 presents the findings of this study, which stemmed from the data collected. The results are separated based on the two phases of the study where phase one involves the quantitative data analysis and phase two outlines the qualitative data

analysis. Findings are organized based on the two research questions that guided the study and are further subdivided by emerging themes. Findings from student and teacher participants are discussed separately.

In Chapter 5, a discussion of the study's results is presented. Data from Chapter 4 are taken and framed according to the research questions and theoretical framework of this study. Findings are discussed according to Figure 2, which is shown at the beginning of this chapter. The implications of this study are then addressed according to the implications that this work has for practice, theory, and further research.

CHAPTER TWO: LITERATURE REVIEW

The purpose of this literature review is to define and describe formative assessment and its role in the promotion of student learning, motivation, and self-efficacy. This is accomplished through the presentation of information and research findings, which have been gleaned from various sources including journal and scholarly articles, textbooks, and the Ontario Ministry of Education's policy documents.

Defining Formative Assessment

A number of definitions of formative assessment can be found in the literature; however, the common theme is that its primary purpose is the promotion of student learning (Black & Wiliam, 2004). By contrast, summative assessment, also known as assessment of learning, is implemented for the purposes of accountability, ranking, or identifying competence (Black et al., 2004). Formative assessment is ongoing and takes place during the learning process, while summative assessment occurs at the end of the learning process (Stiggins, 2005; Volante & Beckett, 2011).

Black and Wiliam (1998a, 1998b, 2004) have had a significant influence on the literature related to formative assessment. Black and Wiliam (1998b) view assessment as an activity that is implemented by teachers or students and provides information that can be utilized to modify teaching and classroom activities. In order for assessment to become formative, the information that is gained must be used to make modifications to teaching and classroom activities to address the needs of students (Black & Wiliam, 1998b). Similarly, Andrade and Cizek (2010) define formative assessment as:

The collaborative processes engaged in by educators and students for the purpose of understanding the students' learning and conceptual organization, identification

of strengths, diagnosis of weaknesses, areas for improvement, and as a source of information that teachers can use in instructional planning and students can use in deepening their understandings and improving their achievement. (pp. 6–7)

Both Black and Wiliam and Andrade and Cizek place emphasis on the purpose of the assessment rather than the task or tools being used. In contrast, Stiggins (2002, 2005) defines formative assessment more narrowly as assessment that provides frequent information only to teachers about students' progress in mastering curriculum standards.

In some literature, assessment for learning is associated with formative assessment. For example, Black et al. (2004) present formative assessment in relation to assessment for learning, where assessment for learning is defined as “an assessment for which the priority in its design and practice is to serve the purpose of promotion of students' learning” (p. 10). Once the information is used to adapt teaching, it then becomes formative assessment. Stiggins (2002, 2005) considers assessment for learning as an approach to formative assessment where the purpose is to inform students about the progress of their learning. According to Stiggins (2005), assessment for learning focuses on “day-to-day progress” (p. 328) while formative assessment focuses on the achievement of standards. The Assessment Reform Group (2002) uses assessment for learning as an overarching construct, where it is defined as “the process of seeking and interpreting evidence for use by learners and their teachers to decide where the learners are in their learning, where they need to go and how best to get there” (p. 3). This involves principles that are central to formative assessment practices such as developing students' capacity to self-assess. Earl and Katz (2006) view assessment for learning as being associated with formative assessment; however, they believe that assessment for

learning involves teachers' use of assessment to determine students' understanding, misconceptions, and gaps in learning. According to Earl and Katz, this form of assessment occurs during the learning process, and the information gained is used to modify teaching and learning activities.

Within the context of Ontario policy, the Assessment Reform Group (2002), as well as Earl and Katz (2006), have had considerable influence on the way the terms formative assessment and assessment for learning are used. The term assessment for learning is currently used instead of formative assessment because the former is believed to emphasize how the information is used (Ontario Ministry of Education, 2010). The Ontario Ministry of Education (2010) claims that assessment for learning encompasses diagnostic assessment and some aspects of formative assessment while other aspects of formative assessment, such as self-assessment and peer assessment, are considered assessment as learning. Teachers' use of assessment as a tool to improve student learning and modify instructional steps encompasses assessment for learning, while students' use of assessment is separated and considered assessment as learning (Ontario Ministry of Education, 2010).

In their seminal work, Black and Wiliam (1998a) stated that "the term formative assessment does not have a tightly defined and widely accepted meaning" (p. 7). Interestingly, this belief still holds true today, as varying definitions can be found within the literature. For the purpose of my research, formative assessment will be interpreted based on Black and Wiliam's (1998b) and Andrade and Cizek's (2010) definitions, which place emphasis on the purpose of the assessment; that is, to improve student learning. These definitions are best suited for my research because they not only stress the

collaborative process of formative assessment, which incorporates not only assessment implemented by teachers, but also students' self-assessment, which has implications on self-efficacy and motivation as will be discussed in subsequent sections.

Impact on Student Learning

Within the curriculum documents for secondary school mathematics, the Ontario Ministry of Education (2005) states that “the primary purpose of assessment and evaluation is to improve student learning” (p. 17). Research indicates that assessment can improve learning if it provides information that can be utilized to modify teaching and learning activities to address students' misconceptions or gaps in learning (Black & Wiliam, 2004). As Yin et al. (2008) found in their study of 12 middle-school science teachers and their students, “simply embedding [formative] assessments in curriculum will not impact students' learning and motivation, unless teachers use the information from embedded assessment to modify their teaching” (p. 354). In an extensive research review conducted by Black and Wiliam (1998a), it was found that the effect sizes for formative assessment activities ranged from .4 to .7. In a follow-up project of 19 classes across two school districts, Black et al. (2004) found that the implementation of formative assessment strategies improved student learning with an average effect size of .3 standard deviations. It is important to note that findings have also indicated that learning gains are greatest among low achievers (Black et al., 2004; Black & Wiliam, 1998b; Yin et al., 2008). Black et al. identify five specific formative assessment strategies that are associated with improvements in student learning. These strategies are questioning techniques, feedback without grades, self-assessment, peer assessment, and the formative use of summative assessments.

The use of questioning techniques, such as increasing wait time and framing questions in a way that can be used to explore student understanding, informs teachers about students' prior knowledge as well as gaps in learning and misconceptions that their students may have (Black et al., 2004). Consequently, teachers are provided with the necessary information to differentiate learning by modifying instruction, resources, and the way in which students are grouped (Earl & Katz, 2006). Questioning techniques develop student learning by exploring with students important issues central to achieving learning goals. Questioning techniques are not targeted at searching for a specific, correct answer, but rather at developing and improving understanding (Black et al., 2004).

In a research review that examined classroom evaluation practices, Crooks (1988) discussed the importance of specific feedback to help students become aware of, and thus correct, misconceptions and improve gaps in learning. Earl and Katz (2006) describe feedback as the link between assessment of a student's understanding and the actions that occur to improve learning by making connections between his or her current understanding and learning goals. In a study of Grade 9 and 10 students, Peterson and Irving (2008) found that students wanted "honest and concise feedback focused on how to bridge the gap between where they are and where they need to be" in order to be able to improve their understanding (p. 249). Earl and Katz underline the importance of providing immediate, specific, and detailed feedback without grades in order to effectively guide students' understanding. However, Crooks points out that a great deal of emphasis in classrooms is placed on grading rather than effective feedback. Interestingly, this situation still applies to today's classrooms. To this point, Volante and Beckett (2011) note that teachers face challenges with providing feedback without grades,

particularly at the secondary school level. However, as Black et al. (2004) note, emphasis on feedback rather than grades is essential to improve learning, because assessment is viewed as a step in the learning process rather than a competition or summative judgment. Descriptive feedback should outline what students have done well, what improvements need to be made, and what steps need to be taken to improve (Black et al., 2004).

Both self-assessment and peer assessment are formative assessment strategies that are linked to improved student learning (Assessment Reform Group, 2002; Black et al., 2004; Earl & Katz, 2006; Stiggins & Chappuis, 2005). The use of self-assessment enhances the development of students' metacognitive processes, such as monitoring their own learning and using their judgment to modify their thinking, which are essential for learning (Earl & Katz, 2006). Similarly, Black et al. (2004) note that in order to achieve a learning goal, it is necessary that students understand the goal and have the ability to determine what is required to achieve this goal. Self-assessment and peer assessment provide the opportunity to practice these necessary skills. Stiggins and Chappuis (2005) state that self-assessment enables learners to take control of their own learning. Similarly, the Assessment Reform Group (2002) notes that through the development of the skills necessary for self-assessment, teachers enable students to acquire the desire and ability to be in charge of their own learning. Peer assessment further promotes learning because students are able to receive feedback about their work in the language of their peers. It should be noted that students may be more inclined to accept feedback from peers rather than the teacher (Black et al., 2004). However, Black et al. note that teachers must first help students develop the skill of self-assessment and peer assessment before students are

able to benefit from the implementation of these formative assessment strategies. Despite the learning gains associated with self-assessment and peer assessment, teachers struggle with effective implementation of these formative assessment strategies (Volante & Beckett, 2011).

Summative and formative assessments are not mutually exclusive (Volante & Beckett, 2011). The formative use of summative assessments is a strategy associated with improved student learning. This improvement occurs when students review their completed summative assessments and implement self-assessment strategies to assess their learning and address deficiencies. It is important to continue the learning process after a summative assessment is completed. Furthermore, an upcoming summative test can provide an opportunity to reflect on what has been learned in order to prepare adequately for the test. The goal is to make summative assessment an integral part of the learning process (Black et al., 2004). However; students require support developing the skills necessary for the formative use of summative assessments. In a study of Grade 9 students' use of self-regulated learning strategies before and after assessment, researchers found that "although most students believe in the value of revision, they often fail to employ effective revision strategies and many fail to use assessment results formatively" (Tanner & Jones, 2003, p. 275). Similarly, Peterson and Irving (2008) presented findings, which suggest that although students wanted feedback to improve their learning, there was little evidence of goal setting or self-regulated learning based on the assessment results and feedback.

Impact on the Self-Efficacy and Motivation of Students

In order to achieve academic success, students must obtain a sense of control over their own success (Stiggins, 2010). This belief in one's competence and ability to successfully complete a task is defined as self-efficacy (Bandura, 1977, 1989). It is essential that students become more confident in themselves as learners in order to continue taking the risk of trying to learn (Stiggins, 2002). Plenty and Heubeck (2011) underline the importance of students' persistence and self-efficacy as they found strong positive association between these factors and achievement in mathematics in their study of 1,014 students in Grades 7 to 11. Similarly, in commonality analyses of four different studies involving students in Grades 6 to college levels, Zientek and Thompson (2010) found self-efficacy to be the best predictor of mathematics achievement.

The impact that assessment results have on student motivation and self-efficacy is highlighted by Stiggins (2005) who states:

Students are deciding whether success is within or beyond reach, whether the learning is worth the required effort, and so whether to try or not. The critical emotions underpinning the decision making process include anxiety, fear of failure, uncertainty, and unwillingness to take risks—all triggered by students' perceptions of their own capabilities as reflected in assessment results. (p. 325)

The implementation of formative assessment strategies has been associated with a positive impact on student self-efficacy and motivation (Assessment Reform Group, 2002; Black et al., 2004; Black & Wiliam, 1998a; Cauley & McMillan, 2010; Crooks, 1988; Jones & Morland, 2005; McMillan et al., 2010; Stiggins, 2002; Stiggins & Chappuis, 2005). In order to improve student motivation and self-efficacy, it is necessary

that teachers implement formative assessment strategies to improve students' perceptions of the goals, purposes, and uses of assessment results (Hughes, 2010). Specifically, the use of descriptive feedback, self-assessment, and peer assessment are linked to increased student motivation and self-efficacy (Adediwura, 2012; Assessment Reform Group, 2002; Black et al., 2004; Cauley & McMillan, 2010; Chan & Lam, 2010; Crooks, 1988; McMillan & Turner, 2014; Natriello, 1987; Rakoczy, Klieme, Bürgermeister, & Harks, 2008; Stiggins & Chappuis, 2005).

Feedback

As Stiggins (2010) states, “teachers must understand how to help students build a strong sense of academic self-efficacy by helping them understand what success looks like and then showing them how to use each assessment to attain even closer approximations” (p. 243). The formative assessment strategy of feedback without grades is one way teachers can contribute to students' development of strong self-efficacy and motivation. Black et al. (2004) discuss how the use of feedback supports students' motivation and the belief that they have the ability to improve. When feedback demonstrates to students what can be done to improve, a task-involved orientation is encouraged, which emphasizes the importance of effort. This emphasis on effort leads to improved learning by promoting students' motivation to invest effort (Black et al., 2004). Moreover, when performance is attributed to effort, students are placed in control of their learning, which fosters the belief that they are capable of learning (Cauley & McMillan, 2010). In contrast, feedback in the form of grades encourages ego involvement, which focuses students on their ability. As a result, the self-esteem and motivation of low achievers is negatively impacted (Black et al., 2004).

Rakoczy et al. (2008) found that informational feedback, which provides students with information on how to improve, leads to increased intrinsic motivation among secondary school mathematics students. Similarly, in a study of two Grade 6 literacy teachers and their students, Murtagh (2014) found that students perceive descriptive feedback to be the most beneficial for their motivation, as opposed to evaluative or phatic feedback. Phatic feedback affirms the exchange of information such as a nod or check mark on student work. However, Murtagh also suggests that if teachers mark every piece of student work, this can lead to an over-dependence on teacher feedback and negatively impact students' intrinsic motivation. McMillan et al. (2010) presented results from a study of 161 secondary teachers and 3,242 of their students from Grades 6 to 12. Results indicate that students perceived that teacher practices such as making written comments, stressing the importance of learning, and praising hard work when wrong were positively correlated to student motivation. Similarly, in a recent study of 64 elementary and middle school students' perceptions of assessment, McMillan and Turner (2014) found that students value feedback and that motivation can be improved through assessments that indicate areas that need improvement. In this study of 240 students, results indicate that informational feedback "that gives students cues on how to proceed leads them to feel excited, stimulated, and interested in the material and to report elaborating the material in more depth, which in turn leads to higher motivation in these lessons" (p. 121).

Chan and Lam (2010) examined the effects of evaluative feedback on students' self-efficacy in English vocabulary acquisition in a sample of Grade 7 and 8 students over two studies. Results of these studies suggest students who received summative feedback after failure in a test had a greater decrease in their self-efficacy than students who

received formative feedback. Similarly, students who received self-referenced feedback rather than norm-referenced feedback after failure on a test demonstrated greater self-efficacy. Chan and Lam suggest formative and self-referenced feedback enable students to perceive a sense of control over their progress, which positively impacts their self-efficacy.

The impact of descriptive feedback can also be seen in previous reviews on the effect of assessment. Natriello (1987) presented the finding that, in classrooms where differentiated and specific feedback is implemented, low-achieving students have greater internal locus of control. Similarly, Crooks (1988) found that when descriptive feedback places emphasis on students' progress, students' self-efficacy is positively affected and effort attributions are also encouraged.

Self-Assessment and Peer Assessment

In order to foster student motivation, assessment must promote the autonomy of learners (Assessment Reform Group, 2002). The use of self-assessment develops student autonomy and assists students in developing a sense of control over their learning (Cauley & McMillan, 2010; Stiggins, 2002; Stiggins & Chappuis, 2005). These developments occur through the implementation of repeated self-assessment, because students are able to track their improvements and see their growth. This sense of control contributes to students' confidence in their ability to succeed (Stiggins & Chappuis, 2005). As Bandura (1977, 1989) states, it is necessary that students develop a sense of control over their learning in order to be successful. Furthermore, the implementation of self-assessment supports the development of mastery goals, which leads to improved self-efficacy (Cauley & McMillan, 2010). Through supporting students' self-efficacy,

literature suggests that self-assessment also fosters students' motivation. Peer assessment helps learners to develop the skills necessary for self-assessment (Crooks, 1988). In a study of 60 senior secondary school students, Adediwura (2012) found that the implementation of self-assessment and peer assessment in mathematics lessons positively impacts students' self-efficacy and fosters learner autonomy. Results indicated that by assessing peers and their own work through the use of criteria they constructed, students experienced an increase in their belief in their ability to be successful. Adediwura notes that in order to achieve these positive outcomes, marks from peer and self-assessment should remain separate from summative assessment.

This section highlighted the importance of self-efficacy and motivation for the academic success of students, which is central to the rationale of this study. The existing literature has demonstrated the potential for the strategies of feedback without grades, self-assessment, and peer assessment to positively impact student motivation and self-efficacy. However, as McMillan et al. (2010) report, the more types of formative assessment practices teachers implement, the greater the impact on motivation.

Impact in the Mathematics Classroom

The research that has been conducted to explore the impact of formative assessment specifically within the mathematics classroom has focused on specific strategies; namely, feedback (Rakoczy et al., 2008) or self-assessment and peer assessment (Adediwura, 2012). Literature examining the impact of formative assessment within the mathematics classroom is frequently limited to a subgroup of a study's sample with few studies specifically focusing on the mathematics classroom. This can lead to difficulty in interpreting a study's results within the context of the mathematics

classroom. For example, Kirton et al. (2007) examined the impact of formative assessment in primary school and junior high schools and found improved student motivation and confidence as a result of students taking greater responsibility for their learning. Although mathematics was one subject in which formative assessment was implemented, the results of the study cannot be examined solely within the context of mathematics.

This is a noteworthy gap in the literature as the implications of formative assessment have been found to vary based on the content area (Kingston & Nash, 2011). In a meta-analysis examining the effect size of formative assessment on educational achievement for a population of students ranging from kindergarten to Grade 12, the estimated effect size in mathematics was found to be .17 in comparison to English language arts and science with effect sizes of .32 and .09, respectively (Kingston & Nash, 2011). Across the 42 effect sizes that were derived, Kingston and Nash (2011) found that content area had the greatest impact on the effect size in comparison to grade level and treatment type (i.e., the emphasis of the formative assessment intervention, such as curriculum-embedded assessment or computer-based assessments).

In the Context of Ontario

A large-scale study, titled the Curriculum Implementation in Intermediate Mathematics (CIIM) project, was conducted in Ontario to understand how the inquiry-orientated mathematics curriculum is being implemented for Grades 7 to 10 (Suurtamm et al., 2010). Part of the CIIM project focused on the assessment practices of teachers. Suurtamm et al. (2010) found that mathematics teachers in Ontario are emphasizing the use of assessment as support for student learning. Although teachers rely mainly on tests

and quizzes for summative assessments, a greater variety of methods are incorporated when conducting assessment with the purpose of improving student learning. Case studies were presented to provide detailed examples of effective assessment practices. Some formative assessment strategies were discussed including the use of questioning techniques to explore student understanding and the use of self-assessment activities to develop students' awareness of their learning. Suurtamm et al. highlight the perspective of Ontario teachers in regards to the use of assessment to support student learning.

Chapter Summary

Formative assessment has an important role within the Ontario classroom. In light of the most recent policy document on assessment and evaluation, the purpose of assessment in Ontario classrooms is emphasized to be fostering student learning (Ontario Ministry of Education, 2010). Although varying definitions of formative assessment exist in the literature, the common premise is that its primary purpose is to improve student learning. The literature has displayed evidence that the implementation of formative assessment leads to improved student learning; however, less literature surrounds the potential for an impact on student self-efficacy and motivation. Furthermore, it is important to note that studies that include students' perspectives remain limited (Kirton et al., 2007; Miller & Lavin, 2007). As Miller and Lavin (2007) note, there is a "relative neglect of the child's voice" (p. 6) in regards to research and development in the area of formative assessment. My research study therefore addressed this gap in the literature by including the perceptions of students at the secondary school mathematics level, and in a broader sense, contributes to the growing body of research surrounding formative assessment.

CHAPTER THREE: METHODOLOGY AND PROCEDURES

This chapter will discuss the methodology and procedures that were used to carry out this study. This chapter includes a description of the research methodology and design, selection of research site and participants, data collection, data analysis, methodological assumptions, limitations, credibility, and ethical considerations.

Research Methodology and Design

In order to explore the impact of formative assessment on student self-efficacy and motivation, an explanatory sequential mixed methods design was employed (Creswell, 2012). Ivankova, Creswell, and Stick (2006) describe this design as “collecting and analyzing first quantitative and then qualitative data in two consecutive phases within one study” (p. 4). The rationale for implementing this design is that qualitative research provides a more detailed explanation of initial quantitative results. As Creswell (2012) states, “the quantitative data and results provide a general picture of the research problem; more analysis, specifically through qualitative data collection, is needed to refine, extend, or explain the general picture” (p. 542).

Quantitative and qualitative data were collected sequentially in two different phases (see Figure 1) (Creswell, 2012). The first phase involved quantitative data collection and analysis and provided a general understanding of students’ perceptions of the impact of formative assessment strategies on their self-efficacy and motivation. The second phase consisted of qualitative data collection and analysis, which were used to explain the results from the quantitative data. These qualitative data provided a more in-depth understanding of students’ perceptions and included teachers’ perspectives on the impact of formative assessment strategies on student self-efficacy and motivation.

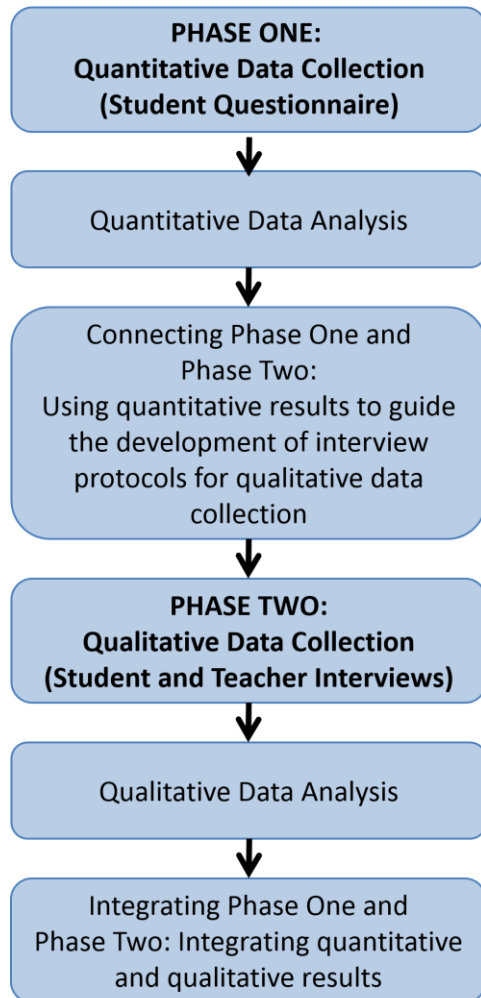


Figure 1. Description of the sequential mixed methods research design utilized.

According to Ivankova, Creswell, and Stick (2006), mixing in an explanatory sequential design can take two forms, both of which occur in this study. First, quantitative and qualitative phases were connected between phases by developing the qualitative data collection protocols based on the quantitative results. Second, the two phases were integrated during the interpretation phase of the study (Creswell, Plano Clark, Gutmann, & Hanson, 2003). This involved the integration of results from the quantitative and qualitative phases during the discussion of the outcomes of the study with respect to the consideration of overall themes and implications.

Site and Participant Selection

The participants in this study included secondary school mathematics students and teachers from two schools in southern Ontario. Purposeful sampling was employed in which, as Creswell (2012) suggests, “researchers intentionally select individuals and sites to learn or understand the central phenomenon” (p. 206). Research sites and participants were selected according to the following criteria: (a) two secondary schools in Ontario and (b) secondary school mathematics classrooms in which teachers implement formative assessment strategies. In terms of implementation, I sought potential teacher participants who incorporated strategies that correspond to the definition presented in the literature review in which the emphasis of the assessment is on improving student learning. In order for assessment to become formative, the information that is gained must be used to make modifications to teaching and classroom activities to address the needs of students (Black & Wiliam, 1998b). Specifically, implementation involves the use of the five specific strategies that Black et al. (2004) identify, which include questioning techniques,

feedback without grades, self-assessment, peer assessment, and the formative use of summative assessments.

The two teachers from the two schools and the students in their mathematics classes were selected and invited to participate in the study. These two mathematics teachers were identified through my informal conversations with them and others in mathematics education forums who identified these teachers as exemplary teachers who were implementing formative assessment strategies. Once the Research Ethics Board's clearance at Brock University and the External Research Screening Committee's approval at the school board were granted, a recruitment email was sent to the principals of the eligible teachers to invite the schools to participate in the study. Four principals were emailed and three agreed to allow their schools be a research site for this study. One principal declined to permit her school to participate in the study as a result of the timing of the invitation. She explained that the timing was inconvenient based on the number of events already occurring at her school. In an initial exploratory phase, I then had informal conversations with the three eligible teachers to verify the use of formative assessment strategies within their classrooms in order to determine eligibility as potential participants and their classrooms as research sites. Since one teacher was not currently teaching two mathematics classes, he was no longer considered eligible to participate in the study. The remaining two teachers were provided with a letter of invitation to participate in the study. Participation was voluntary and teachers were able to withdraw from the study at any time.

Each teacher participant was asked to select two of their classes to participate in the study. Teachers were encouraged to select two different courses; however, the selection was left to the teacher participants to minimize the interference with classroom

schedules. All students from the teachers' selected classes were invited to participate in the first phase of the study. Parents of students under 18, and the students themselves, were required to sign a consent form in order to participate in the study as discussed within the section on ethical considerations. A total of 94 students were invited to participate, with 52 consenting to participate in phase one of the study. Recruitment for the second phase of the study also occurred during this initial recruitment. Within the consent forms, there was a section asking participants whether they would agree to be contacted to participate in an interview for the second phase of the study. After the completion of phase one, the student participants who participated and provided consent to be contacted again were invited to participate in phase two of the study. Another consent form was required to be signed by students and parents (if students were under the age of 18) in order for students to participate in phase two. Eight student participants who indicated interest to be interviewed were selected for phase two. Participants were purposefully selected to include four student participants from each teacher and to represent equal gender participation. One student participant who provided consent to participate in phase two dropped out before an interview was conducted. No reason was provided by the student and as a result of the timing during the school year, it was not possible to select another participant. As a result, seven students participated in phase two of the study.

The courses that were involved in this study include Grade 9 Academic, Grade 10 Academic, Grade 12 university-level Calculus and Vectors, and Grade 12 university-level Advanced Functions. The curricula for secondary school mathematics in Ontario are offered in various pathways. Grade 9 and Grade 10 mathematics are offered in either an

academic or applied route. The Ontario Ministry of Education (2005) designs academic courses to “develop students’ knowledge and skills through the study of theory and abstract problems. These courses focus on the essential concepts of a subject and explore related concepts as well. They incorporate practical applications as appropriate” (p. 6). In contrast, applied courses:

Focus on the essential concepts of a subject, and develop students’ knowledge and skills through practical applications and concrete examples. Familiar situations are used to illustrate ideas, and students are given more opportunities to experience hands-on applications of the concepts and theories. (p. 6)

The type of Grade 9 and Grade 10 mathematics courses prepare students for particular destination-related courses later in secondary school including those for university, university/college, college, and workplace preparation (Ontario Ministry of Education, 2005). As a result, the Ontario Ministry of Education encourages students, parents, and educators to select students’ course type based on their strengths, interests, needs, and postsecondary goals. Grade 11 and Grade 12 mathematics courses are offered in four different pathways: university preparation, university/college preparation, college preparation, and workplace preparation (Ontario Ministry of Education, 2007). Each course is designed to prepare students with the knowledge and skills required for their postsecondary goals.

Data Collection

Data collection took place in two distinct phases as can be seen in Figure 1. The first phase involved the collection of quantitative data. This included inviting students to complete a survey questionnaire in which participants were asked to respond to items on

a 5-point Likert scale (see Appendix A). The questions were developed based on existing literature and the theoretical framework for this study. In addition, a pilot test was conducted in order to consider whether there were any issues with the questionnaire in terms of the clarity of the questions and the time required to complete the questionnaire (Creswell, 2012). Creswell (2012) defines a pilot test to be “a procedure in which a researcher makes changes in an instrument based on feedback from a small number of individuals who complete and evaluate the instrument” (p. 390). Because students would be completing the questionnaire, two secondary school students who are family friends were provided the questionnaire and asked to indicate any issues. Based on their feedback and the feedback from my thesis supervisor, the final survey questionnaire was completed as can be seen in Appendix A. The first part of the questionnaire focused on students’ perceptions of mathematics while the second part explored students’ perceptions of the impact of formative assessment practices.

All the students in the selected classes received a paper copy of the questionnaire as well as an envelope within which they were required to seal their completed questionnaire. Each envelope and questionnaire was identified with a number which corresponded to a particular student. Only my thesis supervisor and I had access to the master list of students’ names and their corresponding identification number. The questionnaires of students who did not have parental consent to participate in the study were destroyed and not analyzed. This was done to eliminate the chance of centering out students based on whether or not they participated in the study. All responses to the questionnaire for phase one of the study were confidential.

The second phase of this study involved interviewing students and teachers. As Neuman and Robson (2009) suggest, “the types of responses possible in qualitative interviewing are much more varied and allow the “voice” of the interviewee to be heard” (p. 277). Participants are able to use the words they feel best describe and explain their experiences and feelings (Neuman & Robson, 2009). It was important to establish a data collection process that ensured that participants would feel comfortable participating. As a result, individual interviews were conducted rather than focus group interviews. Because the purpose of phase two was to further explain the results of the quantitative data, the interview protocols were developed based on the quantitative results from phase one (Ivankova et al., 2006). One interview protocol and guiding questions was created for student participants (see Appendix B) and a separate protocol and guiding questions was developed for teacher participants (see Appendix C). Similar to phase one, pilot tests were conducted. The two secondary school students who reviewed the questionnaire were asked to review the interview guiding questions for student participants. Two teacher colleagues were asked to review the guiding questions for teacher participants. Based on their feedback, in addition to the feedback from my thesis supervisor and committee members, the interview protocols and guiding questions were finalized.

One-on-one interviews were conducted and participants were able to choose a convenient time to conduct the interviews. All interviews occurred at each secondary school where the research was conducted. The interviews followed a semistructured format to allow opportunities for follow-up questions if required. All interviews were audio-recorded and transcribed.

Data Analysis

Quantitative data analysis occurred following the data collection for phase one. These analyses included the calculation of descriptive statistics for each item on the questionnaire to describe the overall tendencies in the data that were collected. This included frequencies, percentage distributions, and mode response rates. The mean and standard deviation are presented for the summed Likert scale variables for students' perceptions of mathematics and of each formative assessment strategy. This will be explained further in Chapter 4. Decisions about interview questions for both teachers and students were based on the results from the quantitative data analysis.

After the completion of phase two, the qualitative data were analyzed through coding and thematic analysis. Analysis was done by hand, utilizing the comment feature in Microsoft Word. Prior to coding, interview transcriptions for both teacher and student participants were read in order to gain a general sense of the data (Creswell, 2012). During this preliminary exploratory analysis, I wrote some short phrases and ideas in the margins of the transcripts and in a small journal that I kept during the data collection and analysis process. For example, I noted that several student participants as well as the teacher participant from School A referenced homework as a form of self-assessment. I was also able to consider whether I needed more data. Based on the availability of students' and teachers' schedules, I was then able to meet with one teacher and four students for individual follow-up conversations to ask some clarifying questions based on their interviews.

Following the preliminary exploratory analysis, a systematic coding approach was then conducted in which interview transcriptions were reread and prominent phrases or

ideas were highlighted. These concepts were then labelled with a code written in the margin of the transcript. Each passage from the participants was labelled with a code. For example in one passage, when discussing providing students with feedback and letting them improve their work, a teacher participant stated:

I learned that really from, not from being a teacher, I learned that from being a parent. I have three children and their other teachers would do that. Their English teachers, their art teachers, their music teachers, and their photography teachers would give them feedback and say now go work on it some more and they'd hand it in again and they would get more feedback. This is teacher as offering guidance rather than offering an evaluation, you know with your first shot. This is your first and only shot, and this is what it's worth. You know, this is guidance to help students improve. It was brilliant so I thought this is the way I want to be as a teacher. So I'm adapting a non-math model.

This passage was labelled with the code "non-math model." This represents an *in vivo* code as it is phrased in the words of the participant (Creswell, 2012). By coding each concept with the passages, I was able to develop an understanding of the emerging themes within the transcripts.

Within-case and across-case theme development occurred by grouping similar codes together (Creswell, 2012). While reading and coding the transcripts, similar patterns or themes among the codes were listed on a separate paper. For example, the emerging theme of the influence of the teacher on the implementation of formative assessment became evident. This theme appeared among the codes of "strong self as a teacher," teacher offering guidance instead of evaluation, teacher's emphasis,

parenthood/non-math model, previous teaching experiences, *Growing Success*, and curriculum. Once I finished reading and coding the transcripts, I created a list of all codes generated on a separate paper. Related codes were grouped together as categories for my analysis of the interview. An example for one theme that emerged from teacher participants is shown in Table 1. This coding approach was done separately for teachers and students. Once themes emerged for teacher participants and student participants, themes were further categorized based on the research questions of this study. An example for themes from analysis of data from teacher participants is shown in Table 2.

Methodological Assumptions

There were some assumptions in regards to the participants in the study. It was an assumption that the teacher participants were implementing formative assessment strategies on a regular basis in their classrooms. Furthermore, it was an assumption that both student and teacher participants responded truthfully to the questionnaire and interview questions. Additionally, the methodology that was used assumed that the data collection methods addressed the research questions and provided accurate results that contributed to the study of mathematics assessment and education.

Limitations

A limitation of this study is the small size and specific nature of the sample. The sample was narrowly defined in order to select classrooms where teachers were implementing formative assessment strategies. This purposeful sample was required in order to address the research questions. To minimize this limitation, demographic details about the research sites are provided so that other researchers will have sufficient data for comparison to their own sample. Although the study was conducted with only two

Table 1

Example of Coding Procedure for the Emerging Theme: Influence of the Teacher

Theme	Code	Participant and Passages
Teachers' Personal Philosophies	"Strong Self as a Teacher"	Kara (lines 319-323) Once I developed a strong self as a teacher, then I came to this school that is not nearly as progressive or informed of proper assessment. But I feel like I am now strong enough that I can now for sure advocate it for my own students and regardless of what other people are doing, I will demand that I do the right thing for mine, but then I can also start to share it with other teachers.
	Teacher Offering Guidance Instead of Evaluation	Beth (lines 124-128) This is teacher as offering guidance rather than offering an evaluation with your first shot. This is your first and only shot and this is what it's worth. You know, this is guidance to help students improve. It was brilliant so I thought this is the way I want to be as a teacher.
		Beth (lines 505-507) Like no totally, you're a teacher it's about teaching. Assessment is part of your job as a teacher. You're not an evaluator, you're a teacher. This is for teaching purposes.
	Teacher's Emphasis	Emphasis on Peer Collaboration: Beth (lines 148-151) Oh, I think there's a lot of peer assessment formative assessment in my class, because they work in groups of four and they're constantly talking to each other about problems. That's what I want them to do, I want them to go, you know. Here's your problem now go and they're sitting and working it out together. So, I think that's way more powerful than getting information from me. Emphasis on Engaging Activities: Kara (lines 55-559) Or just the little interactive games after the lesson is taught, sort of that consolidation piece if you are doing the three part lesson. How do you know that they know? So finding fun and engaging ways to see if they know. It is just a matter of being creative. Soon as you start doing them with the students and you see how much fun they are having and how much they are learning, then it is easy to keep motivated to do it.
Experiences	Parenthood/ Non-Math Model	Beth (lines 118-122): I learned that really from, not from being a teacher, I learned that from being a parent. I have three children and their other teachers would do that. Their English teachers, their art teachers, their music teachers, and their photography teachers would give them feedback and say now go work on it some more and they'd hand it in again and they would get more feedback. This is teacher as offering guidance rather than

	<p>offering an evaluation, you know with your first shot. This is your first and only shot, and this is what it's worth. You know, this is guidance to help students improve. It was brilliant so I thought this is the way I want to be as a teacher. So I'm adapting a non-math model.</p>
Previous Teaching Experiences	<p>Kara (lines 310-313) "I use to teach at a school that had very strong and progressive assessment values and so that was sort of the expectation among all the teachers. Now I just see the benefit of it in terms of giving students all those chances to show their understanding and to develop their learning. So when you see it in place and how it works, it just makes sense.</p>
<i>Growing Success</i>	<p>Kara (lines 306-310) <i>Growing Success</i>, our assessment policy, it encourages formative assessment, but it says that it's not meant to be part of their report card mark. So I believe that if the Ministry of Education that is sort of our strongest and best leaders has determined that is what is best for students, then that's what we should be doing. And I think that is what made me start with that policy</p>
Interpretation of Policy Documents	<p>Beth (lines 509-511) I read the document and the document makes, like <i>Growing Success</i>, it makes sense. You want to give students the opportunity to do the best they can, not on October 10th, but throughout the course</p>
Curriculum	<p>Kara (lines 118-122) I think in math especially since when the curriculum, the learning expectations, changed and we became about self-regulation, it's also about getting the students themselves to be able to ascertain do they understand a concept and if they don't, how do they go about figuring things out and sort of advocating for themselves and learning for themselves. That I think is another big piece of formative assessment</p>

Table 2

Example of Theme Organization for Teacher Participants

Research Question	Theme
1. Ways in which formative assessment is implemented	Influence of the teacher
	Theory in practice
	Interconnectedness of strategies
	Support and obstacles
2. Ways in which formative assessment impacts self-efficacy and motivation	Formative assessment as an opportunity to “get it”
	“Diverse cliental of learners”

teacher participants, student participants consisted of four classes of students. This issue of sample size was further addressed by triangulating data from various collection methods including questionnaires and interviews to study the sample in detail. As a result of the size and nature of the sample, the generalizability of the study is affected; however, findings from the data provide insight on the potential of formative assessment strategies when applied in mathematics classrooms.

A limitation to the internal validity of this study was the data collection instrument. Because the questionnaire is novel and was developed particularly for this study, the reliability and validity have not been empirically tested; however, the questionnaire was created based on the literature and theoretical framework for this study. To minimize this limitation, external audits were done in order to enhance the validity and reliability of the questionnaire. Moreover, this issue was minimized because the questionnaire served to gain an overview of the research problem while the interviews conducted in phase two were used to explain the quantitative results further.

Because a focus of this study was on the perspective of students, another limitation is the accuracy of students' responses to the questionnaire and interview questions that were designed to measure students' perceptions of formative assessment. In order to minimize this limitation and enhance the validity of data collection, participants were reassured of the anonymity of their responses to the questionnaire and confidentiality of their responses in the interview where pseudonyms were used. Students were encouraged to provide honest and accurate responses.

Another possible limitation is that student participants required parental consent as they may be under the age of 18. Parents may not be willing to have students participate in

studies external to the school board. This was addressed by ensuring that the purpose and importance of the study were discussed in the letter of invitation and by providing parents the opportunity to have questions addressed prior to signing the consent form.

Establishing Credibility

In order to establish credibility of results, member checking, triangulation, and external audits were used. Member checking was implemented to allow participants to validate data collection and analysis in the study (Creswell, 2012). Both teacher and student participants were provided with the opportunity to view the transcript of their interview. Triangulation was achieved by using different methods of data collection, namely survey questionnaires and interviews, and by including both teacher and student participants. An external audit involved review of various aspects of the research by individuals outside of the study (Creswell, 2012). For this study, my supervisor and committee members acted as auditors who communicated an evaluation of the study. Some questions that were considered based on Schwandt and Halpern's (as cited in Creswell, 2012) suggestions included:

1. Are the findings grounded in the data?
2. Are inferences logical?
3. Are the themes appropriate?
4. Can inquiry decisions and methodological shifts be justified?
5. What is the degree of research bias?
6. What strategies are used for increasing credibility? (p. 260)

Furthermore, Creswell and Plano Clark (2007) indicate strategies to minimize the threats to validity of sequential designs in mixed methods research that were

implemented. These included selecting the same individuals for the quantitative and qualitative data collection as well as using a larger sample for the quantitative data collection and smaller group for the qualitative data. Through the use of these primary methods of validating the accuracy of findings, the credibility of this study was enhanced.

Ethical Considerations

An ethics application was submitted to Brock University's Research Ethics Board (File Number 12-128-MGOMBELO) and a research application to the school board's External Research Screening Committee. There were no known or anticipated risks associated with participation in this study. Both teacher and student participation was voluntary.

All teacher participants were given a letter of invitation outlining a brief purpose of the study, what participation consisted of, evidence of ethics clearance from Brock University's Research Ethics Board, and approval from the corresponding school board. Furthermore, teachers were provided with a consent form to agree to their participation in the study. Participants had the opportunity to raise any questions and have them answered by the researcher prior to signing the consent form.

As some student participants were under the age of 18, parental consent was required. Consent forms were signed by both parents and students and included an outline of the purpose of the study, what student participation consisted of, and indication of ethics clearance and approval from the school board. In addition to consent for students to participate in the first phase of the study, consent to be contacted to participate in the second phase of the study was sought. The student participants for which I had permission to contact for phase two and who were selected to participate required a

second waiver of parental consent to participate in interviews. Parents and students also had the opportunity to raise any questions prior to signing either consent form.

In order to establish confidentiality, all student and teacher participants were identified by pseudonyms within all documentation including written transcripts. Furthermore, student participants' answers to the questionnaire in phase one were confidential. In addition to the researcher and supervisor, the teachers may have been aware of the identity of students who participated in phase two; however, responses were confidential. The use of one-on-one interviews facilitated confidentiality and fostered an environment that made participants feel comfortable to discuss ideas. Moreover, participants were able to withdraw from the study at any time.

Chapter Summary

This mixed methods study was designed to explore how formative assessment practices can contribute to improving students' mathematics self-efficacy and motivation to succeed in mathematics. Data were collected over two phases in secondary school mathematics classrooms through the use of questionnaires and interviews. Data analyses were conducted in order to gain an understanding of the implementation of formative assessment practices and what specific strategies influence student self-efficacy and motivation.

CHAPTER FOUR: RESULTS

The purpose of this research was to investigate the implementation and impact of formative assessment strategies on the motivation and self-efficacy of secondary school mathematics students. An explanatory sequential mixed methods design was implemented where data were collected in two sequential phases. Phase one involved quantitative data collection through questionnaires for student participants. Phase two involved qualitative data collection through semistructured interviews with teacher and student participants. This chapter presents the results from the analysis of data. Characteristic of an explanatory sequential mixed methods design, quantitative and qualitative data collection and analyses were done separately and therefore are presented separately within this chapter (Creswell, 2012). First, results from phase one of the study are presented, which involved the analysis of the quantitative data using descriptive statistics. Second, results from phase two are presented where the qualitative data were coded and emerging themes were identified. All data analyses were guided by the research questions, literature review, and theoretical framework of this study.

Phase One

In this section, the results from phase one of the study are presented, which include the analysis of data from individual student questionnaires. The demographic results of students who participated are presented as well as the results from the analysis of the data in terms of students' perceptions of mathematics and of the formative assessment strategies. Descriptive statistics are presented as frequencies, percentage distributions, and mode response rates for ordinal variables, which are the individual items on the questionnaire. The mean and standard deviation are presented for interval

data, which are the summed Likert scale variables for student participants' perceptions of mathematics and of each formative assessment strategy.

Demographics of Student Participants

Table 3 summarizes the demographic information of students who participated in phase one of the study in terms of gender and the secondary school mathematics course enrolled in at the time of the study. A total of 52 student participants, 25 males and 24 females completed the self-administered questionnaire. Three participants did not identify their gender. Out of the 52 participants, 32 were from School A with 21 in Grade 9 Academic and 11 in Grade 10 Academic mathematics courses. Twenty participants were from School B with nine in Grade 12 university-level Calculus and Vectors and 11 in Grade 12 university-level Advanced Functions.

Results from Student Questionnaire

The results from the analyses of data from the questionnaire are separated based on student participants' perceptions of mathematics and of each of the five formative assessment strategies as identified by Black et al. (2004). Tables 4 and 5 outline the identification codes for each questionnaire item. Table 4 outlines all statements in part one of the questionnaire, which addressed participants' perceptions of mathematics. Table 5 outlines the classification of statements in part two of the questionnaire based on the formative assessment strategy addressed by each statement.

Student participants' perceptions of mathematics. The 11 statements, Q1 to Q11 (see Table 4), represent the statements that address student participants' perceptions of mathematics. All statements asked participants to answer based on a 5-point Likert scale. Participants responded to statements Q1 to Q6 on a scale from strongly agree (5) to

Table 3

Demographics of Student Participants in Phase One

Gender	Course				Total
	MPM 1D	MPM 2D	MCV 4U	MHF 4U	
Male	8	7	4	6	25
Female	12	4	4	4	24
Not Disclosed	1	0	1	1	3
Total	21	11	9	11	52

Note. MPM 1D is Grade 9 Academic, MPM 2D is Grade 10 Academic, MCV 4U is Grade 12 Calculus and Vectors, and MHF 4U is Grade 12 Advanced Functions.

Table 4

Identification Codes for Statements That Address Student Perceptions of Mathematics

Code	Statement
Q1	I look forward to doing mathematics.
Q2	I believe I am capable of doing well in mathematics.
Q7	I feel helpless when working on mathematics.
Q8	I get stressed easily when I have to work on mathematics.
Q9	I believe that I have a lot of weaknesses in mathematics.
Q3	My teachers see me as someone who is good in mathematics.
Q4	Other students see me as someone who is good in mathematics.
Q10	I do not feel sure about myself when I am doing mathematics.
Q11	When I start solving a problem, I usually feel that I will not be able to get the right answer.
Q5	I can solve most mathematics problems if I try hard enough.
Q6	I believe that making an effort in mathematics is worth it.

Note. All statements are from part one of the questionnaire.

Table 5

Identification Codes for Statements Classified by the Formative Assessment Strategies

Formative Assessment Strategy	Code	Statement
Questioning	QU1	I feel motivated to respond to a question in class when I am given time to think before having to answer.
	QU2	I am motivated to participate in classroom discussions when I know my teacher is not looking for a right answer, but instead is interested in my thinking.
	QU3	I am more confident in my ability to do mathematics when I am encouraged to express and discuss my thinking in classroom discussions.
Formative Use of Summative Assessments	FS1	When I have the chance to improve my assignments based on my teacher's comments, I feel I am able to improve as a mathematics student.
	FS2	When I have the chance to review my assignments and tests to determine what I need to do to improve for next time, I am more motivated to invest effort to improve.
Feedback	F1	When my teacher gives me detailed feedback on how to improve, I feel that I am able to succeed.
	F2	When my teacher gives me feedback on how to improve, I am more likely to put in the effort to improve.
	F3	I find my teacher's comments on what still needs improvement in my work as motivation to improve.
	F4	I feel more confident in my ability to do mathematics when I am given feedback on what I need to do to improve.
Self-assessment	SA1	I find participating in self-assessment helps me understand learning goals better.
	SA2	I have more confidence in my ability to do mathematics when self-assessment activities help me keep track of my progress.
	SA3	By participating in self-assessment activities, I feel more in control of my own learning.
	SA4	Self-assessment activities encourage me to determine how successful I am by focusing on my own improvement.
Peer Assessment	PA1	Being involved in peer assessment helps me understand learning goals better.
	PA2	Participating in peer assessment activities helps me become better at assessing my own progress.
	PA3	When another student gives me feedback on my work, I feel motivated to make the suggested changes.

Note. All statements are from part two of the questionnaire.

strongly disagree (1) and responded to statements Q7 to Q11 on a scale from strongly disagree (5) to strongly agree (1). Note that responses with a value of five suggest a positive perception of mathematics and, conversely, responses with a value of one suggest a negative perception of mathematics.

Descriptive statistics are presented as frequencies and percentage distributions for participants' responses to statements Q1 to Q11 in Table 6. In addition, the mode is presented for each item on the questionnaire. The mode response rate ranged from 4 to 5 for all statements, which suggests that participants had a positive perception of mathematics. The analysis indicates that participants strongly agreed that they were capable of doing well in mathematics (Q2, 36.5%), that they could solve most mathematics problems if they tried hard enough (Q5, 42.3%), and that they believed that making an effort in mathematics was worth it (Q6, 53.8%). The mean of participants' perceptions of mathematics was 3.60 ($SD = 0.899$), between neutral and agree and tending towards agree, which also suggests that participants have a positive perception of mathematics. This value was determined by the summation of scores from items Q1 to Q11 of the questionnaire (see Appendix A) to calculate a mean score for each participant.

Student participants' perceptions of formative assessment strategies. The 16 statements from part two of the questionnaire (see Table 5) represent the statements that address student participants' perceptions of the five formative assessment strategies. All statements asked participants to answer based on a 5-point Likert scale where participants responded on a scale from strongly agree (5) to strongly disagree (1). Responses with a value of five suggest a positive perception of the formative assessment strategy and responses with a value of one suggest a negative perception of the strategy.

Table 6

Participants' Responses to the Statements Related to Student Perceptions of Mathematics

Code	Responses <i>n</i> (%)						Mode
	5	4	3	2	1	No response	
Q1	13 (25.0)	17 (32.7)	14 (26.9)	5 (9.6)	3 (5.8)	0 (0.0)	4
Q2	19 (36.5)	18 (34.6)	9 (17.3)	5 (9.6)	1 (1.9)	0 (0.0)	5
Q3	5 (9.6)	17 (32.7)	15 (28.8)	13 (25.0)	2 (3.8)	0 (0.0)	4
Q4	8 (15.4)	22 (42.3)	13 (25.0)	7 (13.5)	1 (1.9)	1 (1.9)	4
Q5	22 (42.3)	20 (38.5)	6 (11.5)	3 (5.8)	1 (1.9)	0 (0.0)	5
Q6	28 (53.8)	19 (36.5)	3 (5.8)	2 (3.8)	0 (0.0)	0 (0.0)	5
Q7 ^a	14 (26.9)	19 (36.5)	9 (17.3)	8 (15.4)	1 (1.9)	1 (1.9)	4
Q8 ^a	7 (13.5)	17 (32.7)	10 (19.2)	9 (17.3)	9 (17.3)	0 (0.0)	4
Q9 ^a	7 (13.5)	20 (38.5)	8 (15.4)	12 (23.1)	4 (7.7)	1 (1.9)	4
Q10 ^a	9 (17.3)	16 (30.8)	11 (21.2)	10 (19.2)	6 (11.5)	0 (0.0)	4
Q11 ^a	12 (23.1)	15 (28.8)	13 (25.0)	9 (17.3)	3 (5.8)	0 (0.0)	4

Note. Responses: 5=strongly agree, 4=agree, 3=neutral, 2=disagree, 1=strongly disagree.

^a Responses for Q7-Q11: 5=strongly disagree, 4=disagree, 3=neutral, 2=agree, 1=strongly agree.

The perceptions of student participants on questioning techniques. Table 7 summarizes the frequencies and percentage distributions for participants' responses to statements QU1 to QU3, which address the formative assessment strategy of questioning techniques. The mode response rate ranged from 3 to 4. Analysis suggests that participants agreed that they felt motivated to respond to a question in class when they were given time to think before having to answer (QU1, 38.5%) and that they were motivated to participate in classroom discussions when they know their teacher is not looking for a right answer, but instead is interested in their thinking (QU2, 36.5%). Conversely, the analysis indicates that participants were neutral in regards to feeling more confident in their ability to do mathematics when they were encouraged to express and discuss their thinking in classroom discussions (QU3, 50.0). The mean of participants' perception of the strategy of questioning was 3.69 ($SD = 0.817$), between neutral and agree and tending towards agree. This finding suggests that, overall, student participants had a positive perception of the use of questioning techniques.

The perception of student participants on the formative use of summative assessments. Table 8 summarizes the frequencies and percentage distributions for participants' responses to statements FS1 and FS2, which address the formative assessment strategy of the formative use of summative assessments. The mode response rate to these questionnaire statements was 4. This finding indicates that participants agreed that when they were given the chance to improve their assignments based on their teacher's comments, they felt that they were able to improve as mathematics students. In addition, participants seemed to agree that when they were given the chance to review their assignments and tests to determine what they need to do to improve for next time,

Table 7

Participants' Responses to the Statements Related to the Formative Assessment Strategy of Questioning Techniques (QU1-QU3)

Code	Responses <i>n</i> (%)						Mode
	5	4	3	2	1	No response	
QU1	14 (26.9)	20 (38.5)	8 (15.4)	9 (17.3)	1 (1.9)	0 (0.0)	4
QU2	16 (30.8)	19 (36.5)	14 (26.9)	3 (5.8)	0 (0.0)	0 (0.0)	4
QU3	9 (17.3)	10 (19.2)	26 (50.0)	6 (11.5)	0 (0.0)	1 (1.9)	3

Note. Responses: 5=strongly agree, 4=agree, 3=neutral, 2=disagree, 1=strongly disagree.

Table 8

Participants' Responses to the Statements Related to the Formative Assessment Strategy of the Formative Use of Summative Assessment (FS1-FS2)

Code	Responses <i>n</i> (%)						Mode
	5	4	3	2	1	No response	
FS1	17 (32.7)	24 (46.2)	6 (11.5)	4 (7.7)	0 (0.0)	1 (1.9)	4
FS2	18 (34.6)	25 (48.1)	5 (9.6)	2 (3.8)	1 (1.9)	1 (1.9)	4

Note. Responses: 5=strongly agree, 4=agree, 3=neutral, 2=disagree, 1=strongly disagree.

they felt more motivated to invest effort to improve. The mean of participants' perceptions of the formative use of summative assessment was 4.09 ($SD = 0.811$), between agree and strongly agree and tending towards agree. Overall, student participants seemed to have a positive perception of the formative use of summative assessment.

The perception of student participants on feedback without grades. Table 9 summarizes the frequencies and percentage distributions for participants' responses to statements F1 to F4 that address the formative assessment strategy of feedback without grades. The mode response rate ranged from 4 to 5, which suggests that student participants had a positive perception of the strategy of feedback without grades. Data analysis indicates that participants strongly agreed that when their teacher gave them detailed feedback on how to improve, they felt that were able to succeed (F1, 38.5%). Student participants agreed that when their teacher gave them feedback on how to improve, they were more likely to put in the effort to improve (F2, 57.7%), that their teacher's comments on what still needs improvement in their work served as motivation to improve (F3, 22%), and that they felt more confident in their ability to do mathematics when they were given feedback on what they need to do to improve (F4, 36.5%). The mean of participants' perceptions of feedback without grades was 3.97 ($SD = 0.719$), between neutral and agree and tending towards agree. The percentage distribution of responses and the mode responses suggest that student participants perceived the use of feedback without grades positively.

The perceptions of student participants on self-assessment. Table 10 summarizes the frequencies and percentage distributions for participants' responses to statements SA1 to SA4, which address the formative assessment strategy of self-assessment. The mode

Table 9

Participants' Responses to the Statements Related to the Formative Assessment Strategy of Feedback (F1-F4)

Code	Responses <i>n</i> (%)						Mode
	5	4	3	2	1	No response	
F1	20 (38.5)	18 (34.6)	11 (21.2)	3 (5.8)	0 (0.0)	0 (0.0)	5
F2	15 (28.8)	30 (57.7)	5 (9.6)	2 (3.8)	0 (0.0)	0 (0.0)	4
F3	11 (21.2)	22 (42.3)	15 (28.8)	2 (3.8)	0 (0.0)	2 (3.8)	4
F4	16 (30.8)	19 (36.5)	11 (21.2)	5 (9.6)	1 (1.9)	0 (0.0)	4

Note. Responses: 5=strongly agree, 4=agree, 3=neutral, 2=disagree, 1=strongly disagree.

Table 10

Participants' Responses to the Statements Related to the Formative Assessment Strategy of Self-Assessment (SA1-SA4)

Code	Responses <i>n</i> (%)						Mode
	5	4	3	2	1	No response	
SA1	8 (15.4)	17 (32.7)	17 (32.7)	10 (19.2)	0 (0.0)	0 (0.0)	3,4
SA2	9 (17.3)	18 (34.6)	15 (28.8)	9 (17.3)	1 (1.9)	0 (0.0)	4
SA3	8 (15.4)	22 (42.3)	13 (25.0)	8 (15.4)	0 (0.0)	1 (1.9)	4
SA4	13 (25.0)	20 (38.5)	12 (23.1)	6 (11.5)	0 (0.0)	1 (1.9)	4

Note. Responses: 5=strongly agree, 4=agree, 3=neutral, 2=disagree, 1=strongly disagree.

response rate ranged from 3 to 4, which suggests that participants perceived self-assessment positively. Data analysis shows that student participants agreed that they had more confidence in their ability to do mathematics when self-assessment activities help them keep track of their progress (SA2, 34.6%), that participating in self-assessment activities made them feel more in control of their own learning (SA3, 42.3%), and that self-assessment activities encourage them to determine how successful they are by focusing on their own improvement (SA4, 38.5%). In contrast, an equivalent number of student participants agreed and were neutral in regards to the statement that participating in self-assessment activities helped them understand learning goals better (SA1, 32.7%). The mean of participants' perceptions of self-assessment was 3.58 ($SD = 0.805$), between neutral and agree and tending towards agree. These results suggest that participants have a positive perception of self-assessment.

The perception of student participants on peer assessment. Table 11 summarizes the frequencies and percentage distributions for participants' responses to statements PA1 to PA3 that address the formative assessment strategy of peer assessment. The mode response rate ranged from 3 to 4, which suggests that student participants also had a positive perception of peer assessment. Participants agreed that participating in peer assessment activities helped them become better at assessing their own progress (PA2, 42.3%) and that when another student gave them feedback on their work, they felt motivated to make the suggested changes (PA3, 36.5%). In contrast, participants were neutral in regards to whether peer assessment helped them understand learning goals better (PA1, 38.5%). The results suggest that participants perceived the influence of peer assessment to be positive, which is addressed by P2 and P3; however, they were neutral

Table 11

Participants' Responses to the Statements Related to the Formative Assessment Strategy of Peer Assessment (PA1-PA3)

Code	Responses <i>n</i> (%)						Mode
	5	4	3	2	1	No response	
PA1	8 (15.4)	18 (34.6)	20 (38.5)	3 (5.8)	2 (3.8)	1 (1.9)	3
PA3	7 (13.5)	22 (42.3)	15 (28.8)	3 (5.8)	4 (7.7)	1 (1.9)	4
PA4	12 (23.1)	19 (36.5)	13 (25.0)	3 (5.8)	4 (7.7)	1 (1.9)	4

Note. Responses: 5=strongly agree, 4=agree, 3=neutral, 2=disagree, 1=strongly disagree.

towards the purpose of peer assessment, as addressed by P1. The mean of participants' perceptions of peer assessment was 3.55 ($SD = 0.931$), between neutral and agree and tending towards agree. These results suggest that overall participants had a positive perception of the use of peer assessment.

Results from phase one of the study suggest that student participants have an overall positive perception of mathematics and of the formative assessment strategies. As discussed in Chapter 3, the purpose of phase one was to provide a general understanding of students' perceptions of the impact of formative assessment strategies on their self-efficacy and motivation. The interview protocols for phase two were developed based on these quantitative results with the purpose of explaining the results from phase one further. Consequently, the interviews with student and teacher participants were designed to investigate in what ways formative assessment impacts student motivation and self-efficacy. The following section will discuss the results from phase two of the study, which address the implementation and impact of formative assessment strategies in the secondary mathematics classroom.

Phase Two

The qualitative data in phase two of the study were obtained from individual semistructured interviews. Two secondary school mathematics teachers and seven secondary school students were interviewed. All participants are identified with pseudonyms. Teacher participants were given the pseudonyms of Kara and Beth and student participants were given the pseudonyms of Kim, Johanna, Martin, Mark, Sarah, Holly, and John. This section begins with a description of the demographics of the teachers and students who participated in phase two. Participants presented data that led

to 13 themes emerging from the analysis of student participants' data and six themes emerging from the analysis of teacher participants' data. Themes from the perceptions of student participants are first presented followed by the themes from the perceptions of teacher participants.

Demographics of Teacher Participants

Kara taught Grade 9 and 10 Academic mathematics at School A. Kara has taught for 6 years and during the time that the study was conducted, she was also teaching another section of Grade 10 Academic. The previous year she taught a variety of mathematics courses including Grade 9 Academic and Applied as well as Grade 12 mathematics. She started as a geography teacher, but since her first year of teaching, she has taught primarily mathematics and occasionally some geography and physical education courses. Kara has presented professional development sessions on formative assessment at the annual Ontario Association of Mathematics Educators (OAME) conference the past 2 years. During these sessions, she addressed assessment of, for, and as learning as defined within the Ontario Ministry of Education (2010) document *Growing Success* (see Chapter 1). According to Kara, the purpose of her professional development was to:

Highlight formative assessment as a really strong tool both for teachers to better understand where their students are at...even more importantly for the students to help them see where they are at in their learning so they can make the conscious decision to catch up or to improve or to ask questions, because they actually know whether or not they understand.

She offered this same professional development for various school groups and for her mathematics department at the secondary school where she taught. Kara has also attended professional development on formative assessment offered by the Ontario Institute for Studies in Education during her time as a participant in a University of Toronto study. This study researched Grade 9 Applied mathematics teachers and the implementation of formative assessment strategies to improve results on the Education Quality and Accountability Office's standardized mathematics assessments. Kara noted that this was the first time she was formally introduced to formative assessment and came to understand the benefits of implementing the strategies within her mathematics classrooms.

Beth taught Grade 12 Calculus and Vectors and Grade 12 Advanced Functions courses at School B. Beth has taught secondary school for 15 years, before which she taught at secondary summer school and at colleges. Throughout her teaching career, she has always taught mathematics. During the semester in which the study was conducted, Beth was also teaching Grade 9 Applied. Previously in first semester, she taught Grade 9 Academic, Grade 11 College, and Grade 12 Advanced Functions. Beth has offered professional development sessions at OAME, which addressed her action research project on mathematical thinking. During these sessions she discussed the assessment of student thinking through formative assessments. Beth indicated that over the past 5 years, she has attended at least six professional development sessions on formative assessment both at OAME and offered by her school board. These sessions primarily addressed moving away from assessment of learning to an emphasis on assessment for and as learning (see

Chapter 2). The professional development also highlighted the difference between the purposes of these types of assessment.

When asked how long they have been implementing formative assessment, both Kara and Beth noted that they have been doing so since they began teaching; however, not intentionally. Kara stated, “I wasn’t formally or intentionally doing it. I think teachers often do formative assessment and diagnostic assessments without knowing that it is necessarily what they are doing.” Similarly, Beth noted, “I guess without being conscious of it, [I have been implementing formative assessment] a really long time. ... It didn’t have that name and it just seemed like the right practice.” For example, Beth discussed the formative use of quizzes; that is, quizzes implemented for the purpose of improving student understanding. Beth also discussed the formative use of summative assessments when she provided students with the opportunity to improve their assignments based on the feedback she provided. Even though the teacher participants had different backgrounds and experiences, they both shared a focus on the implementation of formative assessment strategies within their classrooms.

Demographics of Student Participants

Kim, Johanna, and Martin were Kara’s students at School A. Kim and Johanna were two females in Grade 9 in the academic mathematics course and Martin was a male in Grade 10 in the academic mathematics course. All student participants were asked to describe their experiences in their mathematics class on a scale from 1 to 10 where 10 represented a very positive experience and 1 a very negative experience. Kim stated 9 because her teacher created a very welcoming classroom environment, was open to questions, encouraged everyone to participate in class, and was a very energetic and

happy teacher. Similarly, Martin stated “around a 9 or 10” because it was one of his best subjects and he enjoyed it. Last year he did not do well in mathematics, but this year he was focusing more on the subject and was now doing much better. Martin also noted that his teacher created a class website with lessons and homework outlines, which contributed to him staying organized and consequently doing well in the course.

Conversely, Johanna stated 3 because she had a negative relationship with her teacher and felt that her teacher was often “picking on” her. She felt that she was slower than her classmates, but was afraid to ask for extra assistance or extra time from any of her teachers.

Kim described herself as a highly motivated individual who is always motivated to improve in school. She finds mathematics easy, which encourages her to invest effort to improve. She also indicated that she gains motivation from peers, and she stated that “in my math class, there is a lot of smart people so it kind of challenges me to do better so I am up to par with them.” Kim displayed a high self-efficacy as she described herself as capable of doing well at mathematics. In addition, she felt that everyone has the capability of doing well at mathematics: “I think everyone’s capable of doing well at math. It’s just a matter of how much you’re dedicated to it.”

Johanna described her motivation to be strictly defined by her goal of getting a 75% in the course. She explained, “I technically just want to pass my classes and I don’t want to go to summer school for math and I don’t want to take it again.” However, she did feel she was a motivated person because she did not like to give up. Johanna displayed a low self-efficacy in mathematics and repeatedly described herself as “slow.” She indicated that she did not have confidence in her herself when working on

mathematics. She felt that she was slower than others; however, she felt that she would be capable of doing well if she had the right resources, as suggested by her claim that “I’m slower so it’s harder but, like, I can do it. Like, if I have enough time, the resources, and teachers to elaborate.” Johanna indicated that she did not like telling people that she was slow at doing the mathematics work.

Martin described himself as a highly motivated mathematics student. He was always motivated to improve, as suggested by his statement, “I am spending a lot more time studying and sometimes even looking up stuff on the Internet like ... I always try to get better and better for the next unit.” He derived his motivation from the importance of mathematics, stating that “math is needed everywhere. No matter in which area you go, whether you are a doctor, a lawyer, a businessman, math is needed and I believe it is one of the most important subjects needed. So I try to focus on that.” Martin displayed a high self-efficacy as he was very confident in his capabilities, stating “definitely, I am very confident in math and I always try to do better.” Similar to Kim, he believed that everyone is capable of doing well at math, as exemplified by his statement that “it takes time, effort, and if you combine the two and do all the homework [you will be capable].”

Sarah, Holly, Mark, and John were Beth’s students at School B. Sarah and Holly were both Grade 12 female students. Sarah was in the Advanced Functions course while Holly was in the Calculus and Vectors course. Mark was a Grade 11 student in the Grade 12 course, Advanced Functions. John was a Grade 12 student in the Calculus and Vectors course. Beth’s students were also asked to describe their experiences in their mathematics class. Sarah stated her experiences were around 7.5 to 8, because she did not struggle with mathematics and she liked it a lot. She indicated that when she tried, paid attention,

and did her work, she did well in the course and, as a result, had an overall positive experience. Similarly, Holly said that her experiences were around an 8 or a 9 and described her experiences in this class as one of her best in mathematics. She stated:

As opposed to in this class, it's given me more of an opportunity to understand the concept and how to derive the information as opposed to just you are given this and if you have to do this, just take these steps. This is like I feel I could use a whole bunch of different ways to do a question and I'm not stopped to do it one certain way. It's probably why this is probably one of my best experiences in math.

She felt that although mathematics was not one of her best subjects, and that this experience was very positive, because she now understood mathematics better. Mark also described a very positive experience and stated he would rank his experiences at a 10. He indicated that his teacher contributed to a positive experience through providing notes, a lot of examples, and a class website, and that she structured her class in a way that promoted student accountability. Conversely, John ranked his experiences in his mathematics class around a 5 or 6, because he was doing very poorly in the course ever since the units focused on vectors. Earlier in the course when they were learning calculus, he was achieving higher marks and enjoyed his experiences more. He said, "I don't really think about outside of marks. Because I'm in Grade 12 and marks are really important to me." It appeared that his experiences were directly linked to how well he was doing in the course.

Sarah described herself as a motivated mathematics student, which results from liking the subject and because of the importance of mathematics for her future goals. She

indicated that she is upset when she is not motivated as indicated by her statement, “if I don’t [feel motivated], then I just feel down, like why I am not feeling motivated?” Sarah described herself as capable of doing well in mathematics; however, it appeared that she had a fluctuating self-efficacy as she often described herself as “hesitant.” For example, she described her confidence when working on a topic she did not like as follows: “I kind of hesitate, but I try to do the work and stuff and be more confident.”

Holly described herself as motivated, which was closely linked to how well she was doing in the course and whether her mathematics mark was one that universities would look at to decide admissions. Holly also indicated that she was motivated because her teacher focused on real-life applications of mathematics, such as the applications to art. She also noted that she was more motivated because her teacher promoted student thinking and understanding rather than the memorization of facts. Holly displayed a high self-efficacy in mathematics and she described herself as being capable and confident in her ability if she completes the work and tries hard, as noted by her statement “I know that if I ever do badly on something it’s because I haven’t put the work into it.” She described an increased confidence in her ability to do mathematics, because her teacher provided different ways of solving problems and demonstrated an interest in student thinking. This support by her teacher also led Holly to have an increased motivation in mathematics, suggested by her statement that “so knowing that there’s not only one way, like I’m thinking of it a different way and that way can be right ... it just helps me want to do the course work more.”

Mark described himself as a motivated and confident mathematics student as he has always done well. He described himself as motivated as long as the course material

was something that he was capable of understanding. He defined this to be anything up to and including a first-year university-level topic.

In contrast, John described himself to have very little motivation to do mathematics, because he was not doing well and universities were not looking at his mathematics mark. He also discussed an indifference to improving and achieving success in mathematics, as exemplified by his statement that I “rarely would I want to improve,” which appeared to stem from a low level of self-efficacy in mathematics. He indicated that if he does not do well in a subject, he has no motivation. Interesting to note, although it seemed that John had a low self-efficacy, when discussing his confidence in his ability to do mathematics, he stated: “Sometimes I doubt myself in the work I do, but like most of the time I’ll be confident into answering questions even though I may think that I will be wrong half the time.” The students who participated in phase two of the study represented a diverse range of experiences in mathematics classrooms, motivation to do mathematics, and self-efficacy.

Themes Based on Student Participants’ Perceptions

The results of phase two of the study that emerged from the perceptions of student participants are presented in terms of the guiding research questions. The themes concerning the implementation of formative assessment include (a) the interpretations of formative assessment strategies, (b) the interconnectedness of the strategies, and (c) taking formative assessment seriously. Next, the results concerning the impact of formative assessment strategies on student self-efficacy and motivation are presented. The overarching themes applicable to all formative assessment strategies are first presented. These include (a) the interpretation of motivation and self-efficacy, (b) the

sources of student motivation and self-efficacy, (c) the connection between motivation and self-efficacy, (d) peer and teacher judgement, and (e) the perceptions of mistakes. Lastly, the themes regarding the impact on student self-efficacy and motivation that are specific to each formative assessment strategy are presented.

Ways in which formative assessment is implemented. Three themes emerged in relation to the perceptions of student participants on the ways in which formative assessment is implemented. The themes are the interpretation of formative assessment strategies, the interconnectedness of strategies, and taking formative assessment seriously.

Interpretation of formative assessment strategies. Analysis of the data suggests that student participants have diverse interpretations of formative assessment strategies. Some interpretations are consistent with formative assessment literature, while others differ. This theme will be discussed in terms of the five formative assessment strategies: questioning techniques, feedback without grades, self-assessment, peer assessment, and the formative use of summative assessment.

Questioning techniques. Student participants outlined the implementation of questioning techniques primarily during classroom discussions. Participants addressed the use of prompting to develop student understanding during lessons. Holly indicated that experiences in Beth's classroom were the first time she was prompted to participate in classroom discussions where the teacher would explore students' ideas and contributions. She described her previous mathematics experiences:

We never had discussions. Like my teacher would never ask me, "How do you think we can do it?" and then did the question according to what a student said. It

would be more like, okay this is what we should do and this is how you are going to do it. So getting to sit down and talk to everybody around me.

In contrast, Holly explained that in Beth's class "it always felt like a discussion in the class. It never felt like sit down and listen to me. It was more like okay, what do you think you should be doing?" Similarly Kim described her teacher probing to explore student understanding, stating "she is trying to get other people to join in on the discussion so everyone feels included and she understands that everybody understood the lesson. ... I find it as she is encouraging you to actually tell what you think." Johanna also highlighted her teacher's questioning to explore student thinking, as exemplified by her statement, "she asked like, 'what do you think?' And then she asked the class, 'put your hand up if you think it's the same thing.' Then it's kind of better." She explained that she was more willing to participate, because there was less pressure the way her teacher asked questions to explore student thinking.

Mark characterized his teacher's questioning techniques as the drive for students to do their own work during classroom discussions. He stated that:

She kind of drives you to do your own work on the smart board when she's working on problems. She is kind of doing it really slowly, so that even if you have done some steps already in your head, gone forward, you are forced to write it down, so that okay, this is how you do it. Then she sees that a lot of people have written it down, then she continues the next step.

Holly also discussed how her teacher's questioning techniques fostered student understanding as suggested by her statement:

She'll just ask and ... whatever the answer is, she'll put that on the board regardless if that's the way she would want to do it or not like to do it. And what I love is that she took one class ... she approached the same question in three different ways. ... And I was just like, I know how to do these, what's the point? It was just to show which method was more effective and it was just interesting to see. ... But to be able to see that you could have done it three ways, it's the same thing using a different way.

Student participants' perceptions of the implementation of questioning techniques centered on classroom discussions and highlighted the teacher participants' use of prompting to explore student understanding and develop student understanding.

Feedback without grades. Student participants described the implementation of the strategy of feedback without grades through various classroom activities. Participants highlighted the feedback that was provided on quizzes that teacher participants gave for the purpose of providing descriptive feedback instead of marks. For example, Mark described receiving feedback on these quizzes, stating that "if the teacher writes feedback about why you made this mistake. ... It's good because then I can understand how I made the mistake and how I can better myself to not make this mistake in the future."

Similarly, several participants described the teacher feedback provided on summative unit tests. For example, Kim explained, "it was our previous unit test. I got the question wrong in the middle of my solution so that part was circled. So I redid it over a couple of times and I figured out what I did wrong." She believed this feedback to be more helpful than just marking it wrong or giving her a zero on the question. Student participants also described being provided with descriptive verbal feedback when contributing ideas

during classroom discussions, when asking for help during work periods, and when the teacher observed students working together on a problem. Martin described receiving feedback during class work periods, stating that:

We are doing the trigonometry unit. There was a really difficult question that required a lot of thinking. ... I asked her for a technique of how you do it. I didn't really ask her how you solve it or just give me the answer, but I asked her for a technique and she explained it to me and without giving me the answer which really benefited me.

Student participants described the implementation of feedback without grades involving both written and verbal descriptive feedback. Written feedback was given on formative quizzes as well as on summative assignments and tests. Verbal feedback was provided during classroom discussions, group work, and on an individual basis when student participants asked for help.

Self-assessment. Several student participants classified homework as self-assessment. Kim expressed that she considered homework to be self-assessment, suggested by her statement:

I'll consider my homework as self-assessment, because she gives us before each unit ... a list of the homework and the dates. So we have to keep track of that. So I take my homework really seriously. So I do it every night and I take it as a form of self-assessment. ... It just encourages me to do better and it helps me understand so much better.

Similarly, Martin indicated that keeping track of practice questions and completing extra questions was self-assessment. He explained that this was a way to keep track of his

progress and to improve his ability to do mathematics. Sarah portrayed self-assessment as reviewing quizzes and tests and explained, “just looking at how well I am doing and examining my weaknesses and working on that.” Similarly Johanna explained the process of self-assessment she goes through after receiving a marked test back, stating that:

I did the questions [from test] that I didn’t get right. ... I kind of had to figure out how come it’s not right. So I had to go back through my notes and textbooks and everything. Then I was like okay, well I’m not going to make that mistake again for exams.

Holly also discussed self-assessment to be interpreting teacher feedback on tests.

Similarly, Mark considered reviewing his work to be self-assessment, explaining that “I see how I think, how I work. So it definitely helps me understand how I can better my ability.” In addition, Mark identified the Functionner’s Book Beth used in her classroom as a form of self-assessment. This is a book where students throughout the duration of the course document interesting functions. Mark described this book to be self-assessment because he could review his growth as a mathematics student. He explained:

You are basically documenting your progress... If you turn to the first page of the book, you see simplistic ones like $y = \frac{x^2}{x+1}$ Now you see like $y = \frac{\tan^2 x}{\sec^2 x}$; which is really good. It shows me that I have progressed to a higher level, a higher understanding of math.

Participants also suggested that self-assessment activities were best to be completed at home on a voluntary basis rather than as a structured activity in class, as indicated by the statement, “not in class, no. Separately on your own time I think would be best.”

Although student participants did not describe self-assessment to be structured activities

during class time, they perceived self-assessment to be completing homework, reviewing marked summative assessments, reviewing feedback on quizzes and tests, and documenting progression of understanding in journals.

Peer assessment. Student participants identified the use of gallery walks as peer assessment. A gallery walk is an interactive discussion technique where students are actively engaged with other students' mathematical ideas. Students in small groups generate solutions to a mathematics lesson problem. After recording the solution on paper, students engage in small-group discussions about each solution. A gallery walk provides students with "a chance to read different solutions and provide oral and written feedback to improve the clarity and precision of a solution" (Literacy and Numeracy Secretariat, 2010, p. 3). Both Kim and Johanna referred to the use of gallery walks in their classrooms, as noted by the statement:

We've done group work where we do it on chart paper and then we hang it up on the board and then we go around and we have stickers. We put stickers on which one is right. We go through them and see what's wrong with it.

Similarly, Kim included, "we were split into groups and given those big graphing papers. So we got a similar question for all the groups and we had to answer it in the best way possible." Johanna and Kim described the gallery walks as peer assessment blended with teacher feedback to address what students' feedback missed. As Kim explained, "she went over all of them and she pointed out for the groups what we did good and what we could improve on." Similarly, John described peer assessment activities that involved the use of peers' work. The teacher provided the class with a copy of four different, yet correct solutions to a problem completed by peers. Students worked together to determine

what other ways this question could be solved and to assess which method would be most effective.

Analysis of data suggests that student participants perceive peer collaboration to be a form of peer assessment. This perception was predominant among participants in Beth's classes. For example, Holly discussed collaborating with peers who sat in her group, as suggested by her statement, "in the groups since I'm already comfortable with the people, I'd be like what just happened? Could someone please explain?" Moreover, Martin mentioned collaborating with others when peers needed help. He stated that "if I am talking to someone and they look really confused, I might draw a diagram or something if they are a visual learner just so they understand." Interesting to note, John provided a suggestion for how peer assessment could be further implemented. He suggested the use of a blog where students are able to post questions and they can comment on each other's work. Analysis of data therefore indicates that student participants perceive the implementation of peer assessment to involve the use of gallery walks, reviewing peers' solutions to mathematical problems, and collaborating with peers.

Formative use of summative assessments. Student participants from Kara's class described practice tests as the formative use of summative assessments. Prior to each test, students had the opportunity to complete a practice test without the use of the textbook. Participants described this as formative assessment, because it was the opportunity to review their work and to determine what needs to be done to improve based on teacher feedback. This perception is exemplified by the statement:

It's a good opportunity to see how well you do on it. Because if you do really bad on the practice test, you know that you have to go home, study, study, study, do extra questions. Do whatever it takes to do well on that final test.

Although these activities happened prior to the summative assessment for the unit, analysis of the data suggest participants perceived practice tests to be an opportunity to use upcoming summative assessments as formative assessments. Similarly, Beth's students Sarah and Holly considered the use of quizzes as the formative use of summative assessments. Student participants completed quizzes that were not for marks, but were corrected for the purpose of providing students with feedback. Although these quizzes can be classified under the strategy of feedback without grades, analysis of the data suggest some student participants associated it with the formative use of summative assessments. This association may be because in past experiences in classrooms, quizzes were implemented for summative assessment purposes. Participants also described when they were given descriptive feedback on unit tests, which helped them to improve on subsequent assessments. For example, Holly described teacher feedback on how to improve her mathematics communication skills. Holly noted:

She gave me feedback onto what part I'm weak in. ... My communication mark was the lowest. ... It's just making sure your questions look organized, writing f (x), and putting a let statement and things like that. ... I was like oh, that's easy, I can do that. So after that, just applying that to my homework and practicing ... it was just easier on the test. ... When a teacher gives you detailed feedback on what section you are doing not so great in, that's what I find most helpful because you can apply that to the next test.

Participants perceived the implementation of the formative use of summative assessments to include the use of practice tests, formative quizzes, and feedback provided on tests, which helped them to improve on subsequent assessments.

Student participants highlighted the various interpretations of formative assessment in practice in secondary school mathematics classrooms. As this theme suggested, some perceptions are consistent with the literature such as the teacher participants' use of questioning techniques to prompt students during classroom discussions to explore and develop student understanding. Analysis of data also suggests that some perceptions add different examples of the implementation of formative assessment strategies. For example, the perceptions of students that homework is an implementation of self-assessment.

Interconnectedness of strategies. Analysis of data suggests that student participants perceived the formative assessment strategies to be a process where the strategies are interconnected, rather than a set of distinct strategies. Participants described the relationship between the formative use of summative assessment, self-assessment, and feedback without grades. Kim described the process of receiving a quiz or test back and reviewing the provided feedback in order to determine what needs to be done to improve. Similarly, Johanna discussed receiving marked assignments back and the self-assessment process she goes through, as noted by her statement:

When she marks it [assignment], she circles what we did wrong and tells us how to expand on it instead. Then when I go over it ... I will go through the questions

I didn't do right and then I'll write them over, that way it's easier for me to study.

Sarah explained the connection between the formative use of summative and self-

assessment, as indicated by her statement, “I usually collect all my quizzes and my test and look at my weaknesses. So that really helps me do well on the exam.” Similarly Kim highlighted the connection between her teacher’s feedback without grades and the process of self-assessment she goes through in order to improve her understanding. She stated that “I try to do the question over again to see if I can figure it out myself and most of the time I usually do.” Student participants described an overlapping process of receiving feedback on a summative assessment, assessing their work based on the feedback and their own interpretation of what needs to be done to improve, and taking the necessary steps to improve. It is also important to note that some examples participants have provided include quizzes, which teacher participants implemented for formative purposes. Student participants seemed to group quizzes and tests in the same category when discussing the relationship between the formative use of summative assessments, feedback without grades, and self-assessment.

Student participants expressed a connection between peer assessment and self-assessment. Kim described the opportunity to assess her own understanding through peer assessment activities as follows, “I learn from their answers so I look at it and I can see from my answer, what I could improve on and what I did the same.” Similarly, Martin described the process of peer assessment as an opportunity to assess his own understanding, as suggested by his claim that “it [peer assessment] kind of verifies my skills as well.”

Student participants also addressed the connection between the use of questioning techniques and peer assessment. Participants described the use of teachers’ questioning to develop and explore student understanding which leads to peer assessment. For example,

Holly considered classroom discussions as the opportunity to improve understanding, because students are able to provide feedback on each other's' answers and build on the responses. Furthermore, participants described class discussions as an opportunity to combine ideas with peers to answer the teacher's questions. Johanna described classroom discussions as "putting your ideas together" with classmates in order to solve the teacher's probing questions.

Analysis of data indicated that when discussing the formative assessment strategies, it appeared that student participants perceived the strategies to be connected when implemented in practice. The prevalent connections that emerged from student participants' responses include the connection between (a) the formative use of summative assessments, self-assessment, and feedback without grades, (b) peer assessment and self-assessment, and (c) the use of questioning techniques and peer assessment.

Taking formative assessment strategies seriously. In regards to the perceptions of students on the implementation of formative assessment, participants highlighted issues surrounding taking formative assessments seriously. John indicated that because formative quizzes were not for marks, he did not focus on them, as suggested by his statement:

My teacher, told me that they [formative quizzes] won't be counted toward the marks ... so I don't really bother studying for the quizzes where as I study more on the test and do better on the test. ... I don't really pay much attention to them [formative quizzes].

John clarified that "maybe I'm just a little stressed. Like if it's not important, then I don't

want to do it. If it's really important, I would definitely do it." It appears that John was more likely to associate something to be important if it is for marks. This sentiment was reiterated by Holly who felt that she was not motivated to study or prepare for assessments when they are for formative purposes. Holly recognized this to be a fault and something she was not happy with, as exemplified by her statement that "one of the things that I don't like is that in a way it doesn't motivate me to study or do my homework, because I'm like oh, it doesn't count." Similarly, Sarah expressed that because she knows the difference between formative and summative assessment, she does not prepare well for quizzes that are identified as formative since they are not for marks. She stated:

Knowing that an assessment is formative, makes me not really prepare very well for it. But summative assessments going into it, I feel like I need to prepare really well and do my work and ask my peers for anything that I am not sure of or ask my teacher.

Furthermore, Sarah noted that "I feel like formative is not serious enough perhaps and summative really counts. It is what you need to really focus on." Sarah explained some reasons why she possibly feels this way:

Knowing it doesn't count I guess. I feel like it's not really serious enough. Or maybe the way the teacher puts it. Like one day before the quiz she'd say 'oh you have a quiz tomorrow' or maybe it would be a drop quiz. Yeah, so you're not really prepared. Like maybe you've been busy doing other work. So it just makes you feel like oh, maybe I don't need to study for this.

Analysis of data suggests that participants had difficulty taking formative assessment

seriously, in particular because these assessments are not for marks and therefore participants were not motivated to prepare for them.

Although participants suggested that they did not always take formative assessment seriously, they recognized the benefits of the strategies and therefore took into consideration the feedback seriously. For example, Sarah noted:

When we get the feedback [from formative quizzes], then that's where you get your motivation from. ... The results make you more serious, but taking the formative itself just makes you, I don't know ... just makes you feel less serious going into it.

Sarah provided a suggestion to improve this situation. She claimed, "I would give formative assessments more often so that they're less of a quiz. Like I wouldn't call them quizzes, I would just call them something like thoughts of the day." She stated she would change the name because "they are formative ... students have an idea of quizzes, they are similar to tests; they're like small tests." It appears that this perception may be because quizzes in the past were part of students' final grades.

This theme highlights the concerns of student participants with taking formative assessment strategies seriously, primarily because formative assessments are not for marks. However; student participants' responses indicated that they valued the feedback they received on the assessments. It is important to note that participants' responses appeared to be specifically in regards to formative assessment in the form of quizzes as opposed to the other strategies. It is also noteworthy that these perceptions were only from participants in Grade 12.

This section presented student participants' perceptions of the ways in which formative assessment is implemented. The perceptions suggest that there are diverse interpretations of the formative assessment strategies. Some interpretations are consistent with literature, while others appear to differ. Moreover, this section highlighted that student participants perceived that the implementation of formative assessment strategies is a process where strategies are not distinct, but rather are interconnected. Lastly, this section underlined the issues student participants presented in regards to taking formative assessment seriously. Participants' responses centered on discussion of the use of quizzes to provide students with feedback without grades. These themes provide an understanding of the student participants' perceptions of the implementation of formative assessment, while the subsequent section will address perceptions of the impact of the strategies.

Ways in which formative assessment strategies impact the self-efficacy and motivation of students. The analyses of the perceptions of student participants revealed themes related to the impact of formative assessment on student self-efficacy and motivation. The themes are organized according to overarching themes across all formative assessment strategies followed by themes specific to each formative assessment strategy.

Themes across all strategies. The themes that emerged that are not specific to a particular formative assessment strategy include the interpretation of motivation and self-efficacy, the sources of student motivation and self-efficacy, the connection between motivation and self-efficacy, peer and teacher judgement, and the perceptions of mistakes.

Interpretation of motivation and self-efficacy. Prior to discussing how the motivation and self-efficacy of student participants are influenced, it is important to address the theme of how participants define these concepts. Motivation will first be discussed followed by self-efficacy. Johanna described motivation to be the drive to achieve a goal, stating that:

Motivation is like a goal to work towards ... not that someone sets for you, but one that you want to achieve, not that you have to achieve. Something just kind of bubbles. Like I want to do it, I really want to do it.

Similarly, Mark noted:

Well [motivation is] the drive to pursue something that you want to do. ... Well if there is a problem that you can't do and you want to know how to do it ... it drives you to go and find out different ways to solve that problem, to research it.

Sarah also described motivation to be this drive even in light of failures, as suggested by her statement, "it [motivation] is just working hard and staying on track, doing your work, and not giving up like even if you see a bad mark." When discussing motivation, Martin stated:

Motivation is I guess pushing yourself forward and really understanding what is right for you. Pushing yourself forward to do better and better and better. And there has to be that one thing whether it is your mark or maybe you realize that you have to do well in further years, and you just think about that one thing and you say to yourself, I want to do this and that's motivation to me.

Martin described how each student must find their own source of motivation that will help them to continue investing effort in their mathematics studies.

Because self-efficacy is a belief in one's competence and ability to successfully complete a task (Bandura, 1977, 1989, 1994), participants were asked to describe what it means to have the ability to be successful at mathematics. Participants defined this ability as having an understanding of mathematics. Johanna stated that she considered herself to be capable of doing mathematics when "I am able to understand it. Like as long as I am able to understand it and do the work like everybody else, I think that means that I am capable." Similarly, Mark addressed that he believed someone was capable of doing mathematics if they were able to solve mathematical problems. He noted, "well if someone places a problem at your level in front of you, you should be able to solve it with relative ease." Martin highlighted that he believed he was capable of being successful at mathematics when he is able to answer any question, which is achieved by a lot of practice. He claimed:

Capable at math means to do a lot of practice. It means that you don't only sit in class and just listen to the teacher speak and listen to the discussions. But it means that you go home, do questions, do extra questions, because that is the capability of math... You are able to do any question ... and that is being capable at math.

Interesting to note, marks were mentioned only secondarily and not as the primary way to determine whether or not a student is capable of doing mathematics. For example, Martin described marks as "correlated" to a student's capability of doing mathematics, but it does not define it. He stated, "The more you study, the more time and effort you put into it, obviously it correlates to your mark." Similarly, Mark stated that marks were not involved in defining one's capability to do mathematics, but rather defines a student's

ability to not be nervous during an assessment. Sarah was one participant who defined self-efficacy primarily through assessments, as indicated by her statement:

Doing well on the assessments, handing in work on time, doing your homework, and being sure when you do your work, being sure that you are doing the right thing. ... It's closely tied to assessments, but it is also doing your work. Like you have to know what you are doing, you have to do it.

This theme addresses student participants' interpretation of motivation and self-efficacy. Student participants perceived motivation to be the drive to achieve one's goals. In regards to self-efficacy and perceiving oneself as capable, student participants primarily discussed an understanding of mathematics and the ability to solve questions where marks were secondary.

Sources of student motivation and self-efficacy. Student participants highlighted various sources for their motivation and self-efficacy in mathematics. Student motivation will first be discussed followed by self-efficacy.

Several student participants addressed the importance of mathematics when discussing their motivation. Some participants indicated that they believed it was important to put effort in mathematics, because it is a required course throughout all of secondary school. Similarly, Johanna noted the importance of mathematics for postsecondary success, which motivated her to invest effort. She claimed, "I want to be successful when I grow older. So might as well pay attention now, like make sure my future isn't screwed up and slack off now and then have a terrible future." Sarah explained that her motivation to do mathematics was derived from the importance of mathematics for her future career goals, as exemplified by her statement that "I have a

goal and I like math like I said, so I do feel motivated and if I don't then I just feel down. Like, why am I not feeling motivated? I am supposed to." Martin also discussed the importance of mathematics regardless of one's career and as a result, this motivated him.

Some student participants indicated that they were motivated to do mathematics when they found the subject interesting. Sarah noted that she gained motivation when the topic being studied was something that interested her, as suggested by her statement, "I like identities so I find that I am more motivated to just work at it, but if it's something else like graphing, a lot of students don't like graphing or modelling." John highlighted that his motivation varies and is increased when he is interested in the topic. He stated:

My motivation to do math, I guess it kind of varies depending on what we are learning in math. For me personally, I can find interest in something like right away if I feel like I can make a connection to the real world. ... Some things in math I like because you can make a connection to what I like, what I find interesting.

Similarly, Holly described how examining mathematics through connections to applications that interest her increased her motivation, stating:

I feel like a lot of math, it just doesn't seem like a real concept to me. You will see jokes about it too ... someone bought 10 watermelons. Like who is ever going to buy 10 watermelons? ... This is just so irrelevant. ... But then when you look at it from different points of views. For example, my teacher talks a lot about art work and I love art. ... We got this assignment to look over different types of trig functions and log functions. I was graphing a few of them and it was just really

interesting ... looking at the different ways the functions interact with each other.

I printed it out and I coloured it in and it was just really interesting to me.

Interesting to note, Holly indicated that you need to put in effort in order to discover something you are interested in. She explained, “If you don’t put the effort in, you’ll never find something you like in it and when you do put the effort in, you will find one or two things you like that you can really focus on.” Similarly, Mark explained that he gained motivation when his teacher was able to incorporate calculus examples and applications in their advanced functions course. He stated, “She’s always trying to progress us to the next level.”

Student participants also reflected on how their motivation was impacted by their goals for their final grade. Johanna defined her motivation to do mathematics to be defined by her goal to pass the course. When asked about her motivation she laughed and stated, “I technically just want to pass my class and I don’t want to go to summer school for math and I don’t want to take it again.” She expressed how she found mathematics to be difficult and her goal was to achieve a 70% in the course. Similarly, Martin described a high level of motivation with the goal of doing well in the course. He stated, “I didn’t do very well in math last year, in Grade 9. So this year I am really trying to focus on math for it to be my best subject.” Several senior student participants indicated that their motivation was determined by marks and university requirements. Holly stressed that her motivation is increased when the course is one of the prerequisites for university. She said:

I’ll be completely honest. I don’t need this in my top six for university. So I put the ones that I need in my top six above this course so I don’t have all the time to

do the homework and I did do as well [after midterms]. It's 100% because I didn't do all the work.

Because it was nearing the end of the semester, John stated, "University looks at the other courses so I'll be more tempted to do better on them to improve. Whereas in mathematics, the university might not look at this mark so I'm not really motivated to do well." Important to note, John highlighted how he lacked motivation to do math. He indicated, "I don't really have a motivation to do math. I just come to class and do it." Students also discussed marks as a source of motivation, which will subsequently be addressed within the theme of the connection between self-efficacy and motivation.

In regards to sources of self-efficacy, some students discussed comparisons to peers. Mark explained the comparisons he makes as follows:

You should compare to your own progress or someone equal to you or higher.

Because if somehow you have made more progress than they have, then you have learned more and basically it makes you feel that you have learned more than them and you document it.

Similarly, Johanna described herself as capable when "I am able to understand it and do the work like everybody else." John also stated, "I find like other people are smarter than me so I don't feel like I'm capable of doing well in math." Analysis of data suggests that student participants' perceptions of their ability to do mathematics were defined through comparisons with peers.

The ease at which participants believed they could solve a problem appeared to be another source of self-efficacy. It seemed that if Sarah perceived something to be difficult, she was more hesitant and had less confidence in her ability. She explained:

If I look at the work and it's something that I feel hesitant like when the teaching is teaching it. I feel like that hmmm, that looks hard and I look at the work and I just prejudge that it's going to be hard to do. Then I don't work at it as much and I don't feel confident.

Conversely, Holly expressed feeling confident in her ability when she is able to use previous skills to solve problems, stating:

If I look at a question, I can think of the different ways I could approach it. ... So what I like about my teacher is that she always brings up previous years a lot and it makes me rethink okay, I learned this. ... I have to kind of bring it from my head and I realize, oh, that actually makes sense. It just helps me know that I'm not always going to be wrong.

Therefore, some student participants perceived the ease of their ability to solve mathematical problems to define their self-efficacy.

Whether or not participants invested effort in their studies seemed to be another source of student self-efficacy. Several student participants indicated that if they invested effort in their studies, they believed they were capable of succeeding. For example Sarah stated:

I feel like when I try and I pay attention and I do my work, I do really, really well. But when I am not doing my work and not keeping up with the teacher and with the work and discussions in class, then I feel like I fall back behind ... if I just work on it, I get it.

Sarah described working on a topic she did not like as follows, "I kind of hesitate, but I try to do the work and stuff and be more confident." Similarly, Holly highlighted:

I feel confident that if I do the work and I stay on top of everything [I will be successful]. I know that if I ever done bad on something it's because I haven't put the work into it. I can never blame the teacher themselves. ... In calculus I did pretty well and that was because I never missed one question in the homework. I was very motivated to do it ... as long as I put the work into it, it wasn't hard.

Martin suggested that in order to be successful "it takes time and effort." He stated that even if mathematics was difficult, if he invested effort the mathematics was going to become easier. Similarly, Kim expressed that she believed everyone was capable of being successful at mathematics. She claimed, "I think everyone's capable of doing well at math. It's just a matter of how much you're dedicated to it ... it's just if you want to work for it." Interesting to address, John appeared to be in a negative cycle that impacted his self-efficacy. It appeared that he felt he did not do well because he did not try; however, he did not try, because he was not doing well. He stated, "I am capable yes, but I don't try hard enough to do well in math ... like I don't really pay much attention to calculus. Maybe because I'm not doing really well in it." Another very common source of self-efficacy was marks, which will also be discussed within the theme of the connection between self-efficacy and motivation.

This theme describes the sources of student participants' motivation to do mathematics and their self-efficacy. Participants perceived the sources of their motivation to be the importance of mathematics, interest in the subject and authentic applications, and their goals for their final grade. In regards to the sources of participants' self-efficacy, responses identified comparisons to peers, ease of solving problems, whether or not students invest effort, and marks.

Connection between motivation and self-efficacy. Analysis of data supports the literature regarding the link between student motivation and self-efficacy (Bandura, 1989, 1994). It appears that students' self-efficacy impacted some participants' motivation and similarly, that students' motivation impacted some participants' self-efficacy. The influence of this connection on the impact of formative assessment strategies will be explored in Chapter 5. This chapter explores the connection.

It seems that most commonly, student participants' self-efficacy impacted their motivation to do mathematics. Some participants indicated that because they perceived themselves to be capable of succeeding at mathematics, they were motivated. Mark stated that "if [the mathematics work] is close to my level ... definitely I am motivated." Similarly, John explained that his willingness to try to do mathematics depended on whether or not he interpreted the work to be easy or if he knew the topics and therefore felt that he was capable of being successful. Kim discussed an overall high level of motivation as a result of having a high self-efficacy, as suggested by her statement, "I'm motivated to do better in school in general. So math, I find it kind of easy so in a way that encourages me to do better since I find it easy." Some student participants indicated that if they did not feel that they were capable of doing well, then their motivation decreased. Sarah described a decrease in her motivation to do mathematics and participate in classroom discussions when she did not have confidence in her ability. She stated:

If I don't know the answer, I feel like I am more hesitant. ... Yeah 'cause if the teacher is expecting you to know something that maybe you are just learning, then it kind of makes you feel hesitant like maybe I should know that stuff or maybe I am not going to do so well in this course ... it just makes me less motivated.

Some student participants also highlighted that motivation impacts self-efficacy. Martin perceived that being capable of doing mathematics required a lot of motivation. He believed motivation was required to determine your ability to do mathematics, stating that “if you put in effort that’s the only way you will know how good you are at anything ... if you don’t put in effort it’s like you don’t try, you don’t know your limits.” Similarly, Kim believed that if students did not do well in mathematics, it is possibly because they were not motivated enough.

It seems that one reason why the connection between motivation and self-efficacy occurs is that how well a student is doing is a source of both concepts, which is the case particularly when considering marks. Holly indicated that how well she is doing in mathematics impacts her motivation, stating, “my motivation works off of how I’m doing overall in the course.” She explained further, “If I am doing really badly, I will try my best to do the best I can, but even if I put my hardest and I see a bad result, my motivation just goes down.” She described the impact of trying her best and still not succeeding as follows:

At times it can completely kill my motivation too, because it’s like I don’t even want to deal with this course. Like if I’m doing all the work. ... That’s what happened with me in advanced functions. I did all the work and I got not what I was expecting of myself. So to have that happen, it really does kill your motivation.

Holly described feeling little motivation to do mathematics in Grade 9 because she was doing very poorly; however, this year she was doing well and her motivation had increased. John also stated, “If I don’t do well in something, I don’t tend to be motivated

to do it.” Similarly, John discussed his lack of motivation when his marks were low as follows, “if they [marks on tests] are like really low, I just don’t really want to look at it. It loses my motivation to do math kind of thing and like to do well.” It seemed that marks are also a source of student self-efficacy. Holly explained how her marks in Grade 9 decreased her self-efficacy to do mathematics not just in Grade 9, but also for subsequent years, stating:

I just didn’t like math because I never used to do well in it. I remember in Grade 9 ... I was getting a low 70 in math. My teacher had recommended for me to switch into applied math as opposed to academic math. To me it was like a big downer, because to me I’ve always been in academic courses. ... So to hear that, math became my worst subject. I hated it at that point. I guess that has kind of translated onto Grade 10 and Grade 11.

In contrast, Mark considered marks as a source of increased motivation and self-efficacy because he is doing well, as suggested by his claim that “there hasn’t really been a downside for math. Like, I have never gotten a really low mark in any of my courses. So, I kind of feel motivated and confident in my ability to do well, to perform well in math.” Holly also suggested that a student’s perspective impacts how marks affect his or her self-efficacy, as indicated by her statement:

There’s times where you will look at the test and you’ll be like if I only did badly in this one section, I’m not stupid. I can improve in it...If I got an 80 on a test and I was aiming for a 90, it’s like I only have to fix these things and I can get that 90. I’m not that far away from a 90, I can do it. Then, yeah it motivates me a lot,

because I'm not that far away I can do it. But if I'm completely off, that really kills my motivation personally.

She suggested that low marks did not decrease self-efficacy if she perceived there to be a small gap between her marks and what she wanted to achieve. It appears that student motivation and self-efficacy in mathematics are connected through their impact on each other as a result of how well a student is doing as a source of both motivation and self-efficacy.

This theme highlights the connection between student participants' motivation and self-efficacy. Analysis of data suggests that some participants' motivation impacts their self-efficacy and that some participants' self-efficacy impacts their motivation. Moreover, the connection between these two concepts appears to be because how well a student is doing is a source of student participants' motivation and self-efficacy.

Peer and teacher judgement. The impact of formative assessment strategies on self-efficacy and motivation appears to be influenced by student participants' fear of judgement from peers and teachers. The responses of participants suggested that when teachers are implementing questioning techniques, students' willingness to participate was impacted by fear of judgement from peers. Holly stated:

If I can already tell that my answer is going to be wrong, I don't want to say it even though I am sure she would want to hear my wrong answer and then try to get the right answer. Knowing that my answer might just sound really stupid in front of the class, it doesn't push me to be like okay, let's just try.

Similarly, Sarah noted, "I feel less confident to share my answer if I'm not sure of it." When discussing his teacher's questioning techniques during classroom discussions,

John's responses suggested a lack of willingness to participate, because of comparisons to peers. He noted, "I find other people are smarter than me so I don't feel like I'm capable of doing well in math." John's responses also indicated a fear of peer judgment when his teacher provides him with verbal feedback during classroom discussions. Holly expressed a hesitation to ask questions during classroom discussions because she did not want to seem incapable, as indicated by her statement, "because it's in front of your peers and you don't want to look like you're the only one that doesn't understand."

Interesting to note, the responses of student participants also suggested a fear of judgement from their teacher. Although they had a positive relationship with their teachers, they feared looking incapable. Holly stated:

I think every student feels that their teacher is always evaluating them and seeing how they are doing in the course ... but I can see that Miss. Beth does look at each student as an individual and [considers] how they are progressing. I don't feel like she looks at a student and just because they did badly on one thing, she judges their overall knowledge in math like that. I feel like whatever I say she's taking it into consideration ... and she can evaluate my overall impression in math according to that. At times it makes me kind of unconfident to put my hand up and be like okay, is this what you are thinking?

Similarly in regards to her teacher's questioning techniques, Sarah noted, "because when you feel like some people or like your teacher expects you to know something, then you feel like ... I don't know, you feel like you're not in control of things anymore, sort of." Sarah's comments suggested that she feared being wrong in front of her teacher and peers when she felt she was expected to know the answer. It also appeared that John's fear of

judgement impacted how he perceived the feedback his teacher provided him during classroom discussions, as exemplified by his statement that “sometimes I’ll answer question and I’m wrong and she looks at me awkwardly kind of thing and later talks to me. Like in class, tell me why I was wrong and gives me a whole lecture kind of thing.” John interprets his teacher’s verbal feedback to be lecturing instead of constructive feedback. Johanna described a similar perception, stating:

My teacher, if you state something, she’ll like say “good job” or something like that or she’ll say, “no” and then go find someone else. So it depends on how it’s said. Like, if I feel that they are kind of criticizing it [answer] in a bad way, then I kind of get, like put my d’s [defenses] up and I don’t talk to anybody. I just stop talking.

Student participants’ fear of judgement from their teacher influenced the impact of the use of questioning techniques.

It appeared that peer assessment activities are impacted by students’ fear of judgement from peers. Johanna described:

It depends on what we are doing it on. Like if it’s something that I’m confident in then yeah, I feel fine. But if it’s something that I struggle in, I tend to stay quieter and see what everyone else is doing before I do anything or I do what I know. So, if we split it up into parts, I take what I know so I don’t look dumb.

Furthermore, Johanna noted, “if I’m struggling, then I don’t like pinpointing [other peoples’ mistakes] because then I start to ramble, then I look stupid.” Similarly, Sarah expressed a lack of confidence to participate in peer assessment when it is a topic she is not familiar with. She claimed, “If it’s [topic of peer assessment] something like going

into a new lesson and then going ‘okay, what do you guys know so far?’ And then I feel like I am more hesitant [to participate].” Furthermore, Sarah described that she only felt comfortable receiving feedback from peers when she is confident in the material. When discussing peer assessment, Holly noted:

What if the teacher thinks that I’m the only person that doesn’t get it, or what if my peers think that I’m the only person that doesn’t understand? ... If it was a large group [that completed a question], like if it was four people that did it together, I probably would still feel kind of scared to be like “okay, what did you do?”

Interesting to note, conversely Holly stated that when working with a small group of peers who she is comfortable with, she will ask questions and clarifications if she does not understand. She explained:

There will be something on the board and it was the group in my class that is really good at math and I was like okay, I don’t want to approach them, they kind of scare me. I could see my teacher was like that’s right, that’s perfect and I didn’t understand. But in groups since I’m already comfortable with the people I’d be like what just happened?

Johanna also indicated that feedback from peer assessment was easier to accept when it is not in regards to her individual work, but rather to a group’s work. She stated:

If they are giving it to us group wise, then it’s easier for me to take it. Then I’ll be like oh, well we did this wrong. So it’s easier when it’s like a group, then when it’s directed towards you.

Participants’ fear of judgement impacted the use of questioning techniques and peer

assessment in regards to students' willingness to participate and their interpretation of feedback from peers or the teacher. Consequently, the benefits of formative assessment may not be achieved when students are not willing to participate or are not receptive of the feedback provided with the intent to improve learning. Therefore, student participants' fear of judgement from their teacher or peers appears to influence the impact of formative assessment strategies on student motivation and self-efficacy.

Perceptions of mistakes. Students' perceptions of the impact of formative assessment strategies on self-efficacy and motivation appear to be shaped by students' perceptions of mistakes. Some participants perceived mistakes to be an opportunity to receive constructive feedback and therefore considered the process as a learning experience. When discussing the formative use of summative assessments, Kim stated:

I view it [mistakes] as a chance to learn ... I don't really frown upon my mistakes. I kind of just look at it, and I try to figure out what I did wrong so then for the next time I get a similar question, I know how to do it.

Similarly when addressing this formative assessment strategy, Martin explained:

When I get to review, I get to see where my weaknesses are. ... I just see what I need to study in preparation for the final exam, which is very important. My strengths is where I guess I should still keep practicing so I don't lose the ability of performing certain types of questions. But definitely the weaknesses I try to improve upon.

Sarah highlighted that she feels better about mistakes and considers it as a learning experience when she is given the opportunity to improve from her errors. Without the opportunity to improve, she perceived mistakes more negatively. Interesting to note,

Mark described mistakes as a learning opportunity only when they are not simple errors, as indicated by his claim, “if it’s an addition or subtraction mistake, no it’s not a learning opportunity. But, it is if you got a bigger mistake.”

When discussing the formative assessment strategy of feedback without grades, Martin described it as, “positive criticism to see that I make mistakes, no one is perfect.” Similarly Mark also stated, “I kind of take it [feedback on mistakes] as positive as I can even if it is like fully negative. I try to take it in a way like okay; I have to improve on this. So yeah, I pretty much try to be optimistic towards that.” Mark described mistakes as a learning opportunity during formative assessment, as suggested by his statement:

She [teacher] gave me a parabola of $y=x^2$ and she asked me, “What kind of symmetry does this have?” I said even, which is wrong because it has symmetry above the y-axis. It is an even function. So I lost all my marks for that question but the thing is, it’s formative so it’s okay. So I learned the difference between an even function and symmetry above the y-axis.

Mark was referencing the quizzes Beth uses to provide students with feedback without grades. Similarly Sarah explained:

When she points at your mistakes and says there is a problem with your form or maybe this equation you didn’t write it the right way, then I am just like okay, I will work on it. Or maybe I have done the homework and I was confident going into the evaluation, but then maybe I misinterpreted things and that happened before...when she gives us feedback, it just makes us understand the real thing, what we are supposed to do.

Mark perceived mistakes during peer assessment positively, as exemplified by his

statement, “well I am actually optimistic towards it [making mistakes]. I don’t really take it as he’s helping me, I am stupid. ... It’s more like, alright he’s helping me, I am learning something new. I am learning my mistake, what happened.” Student participants who had a positive perception of mistakes appeared to be more perceptive of formative assessment strategies and thus the learning opportunities provided by these assessment strategies were more likely to positively impact their self-efficacy.

In contrast, student participants who had negative perceptions of mistakes did not always perceive formative assessment opportunities to be learning experiences and instead, their self-efficacy may negatively be impacted. When discussing the formative use of summative assessments, Johanna indicated that when she does poorly on an assessment, she responds as follows, “I get rid of it [the assessment]...because I don’t want to be reminded of it.” Similarly, John described:

I don’t really look over my quizzes and assignments after they’ve been marked.

But if they are like really low, I just don’t really want to look at it. It loses my motivation to do math kind of thing and like to do well. It’s like I get a low mark, it’s like oh darn, I’m doing really badly in this class. It doesn’t really help me to improve my math.

In regards to his teacher’s feedback without grades, John stated that “I would read the feedback, but like I said, I wouldn’t really perform on the feedback.” Similarly when discussing questioning techniques he stated, “I don’t find it helpful. Like I’m not motivated to find out why I’m wrong. I just like to express myself. I don’t like the aftermath.” It appears that both Johanna and John did not perceive mistakes as a learning opportunity, but rather something negative to ignore. Their perception of mistakes may

negatively influence the impact of formative assessment on their low self-efficacy.

The perceptions of student participants of mistakes appear to influence the impact of formative assessment on motivation and self-efficacy. Participants discussed the formative use of summative assessments and feedback without grades. It seems that student participants who perceive mistakes to be a learning opportunity are more likely to be positively impacted by formative assessments. In contrast, participants with a negative perception of mistakes and who do not consider mistakes as a learning opportunity may be negatively impacted by formative assessment strategies.

Themes related to specific strategies. Analysis of data revealed both positive and negative impacts of the formative assessment strategies. Results are specific to each formative assessment strategy and as a result, data are organized and presented based on each strategy.

Questioning techniques. This theme addresses the impact of the use of questioning techniques on the motivation and self-efficacy of student participants. Participants highlighted positive impacts of the use of questioning techniques. Some students described questioning techniques to be motivational. For example, Mark explained that his teacher's prompting is motivation to participate and continue trying, stating:

It's just our discussions about a certain question or an example. She will be like, "What should I do next?" Then a bunch of people raise their hand and she picks someone. And they say [their response], and then she says "not quite, but yeah, you are on the right track." That kind of thing, yeah it really motivates me.

Similarly, Sarah described her teacher's questioning techniques as something that

“pushes you.” Martin stated that it “motivates me more,” because he is able to share his thinking with peers. Student participants also discussed how they were motivated when the teacher asks questions that are not just concerned with the correct answer, but are used to explore student thinking. Kim explained, “I find it as she is encouraging you to actually tell what you think.” She continued to explain that, “it motivates me more, because I feel that she is more approachable and that’s always a good thing.” Similarly, Johanna reflected that this made her want “to put in more effort” and “it makes me want me to do math more.” Holly addressed that she loved how her teacher did not only focus on one correct answer, as noted by her statement:

That’s my favourite thing, because she never stops from doing the question the way the student wants to. She’ll never search for the right answer. She will just search for what we are thinking. And even if I am really close to it, she will kind of drop hints to be like “okay, that’s kind of close, but you are still kind of not there.” And I’ll be like, oh okay.

Holly also indicated that her teacher’s questioning techniques made her more motivated to do mathematics and, in particular, come to class because she felt that the classroom discussions that ensued were very important. She explained:

But with this class what I realize is that if I don’t go to the class, I’m obviously missing something. One person probably said some breaking news that I’m going to miss and then it’s like no, I seriously need to go to class, what if I miss it?

Interestingly, Sarah also believed that her teacher’s questioning techniques are motivational, because she gains motivation from peers’ successes. This is exemplified by her statement:

It makes me feel encouraged to know the answer. And like when I hear people's answers, like a lot of people are really smart and sometimes they know things more than we know. Like they've studied something extra for example or did reading ahead. So that makes me feel like oh, maybe I should catch up.

The strategy of questioning techniques is identified by Holly as the formative assessment strategy she found increased her motivation the most.

Student participants also addressed the positive impact that the use of questioning techniques had on their self-efficacy. Johanna noted an increase in confidence in her ability because her teacher's questioning techniques and classroom discussions helped her focus on the important aspects of a topic. She explained, "It makes me think that if I remember this, like I have to study this ... then I will do good on the test and everything." Kim also perceived an increase in confidence in her ability when her teacher asked questions that required her participation even if she did not know the correct answer. She explained:

We were doing linear relations. I couldn't really get one part. So, I wasn't participating. And then she noticed so she made me do one question and I kind of messed up in the middle, but yeah, she told me what I did wrong ... it made me understand it more so I could do the other similar questions.

She clarified that she no longer doubted her ability because, "I learned what I did wrong. I was able to answer other similar questions." Martin noted an increase in confidence in his ability because he knows the answers to his teacher's questions and is able to share his knowledge. He stated:

It makes me feel better at math really ... because a lot of the time the night before, I have already done the concept and I know she's not even looking for the right answer. I try not to blurt it out or something. I just try to guide everyone to it if I am the one answering.

Martin also explained that questioning techniques increase his confidence because he feels like a leader, as indicated by his statement:

I guess [it makes me feel] almost like a leader, because I already know the math and ... other students may not know the concept so I guess just me helping out or maybe just giving other students hints so they achieve the answer because I already know.

Holly also claimed that her confidence in her ability increases as she is able to share her thinking, stating:

It always felt like a discussion in the class. It never felt like sit down and listen to me. It was more like okay, what do you think you should be doing? That's probably why I felt a lot more confident in this class as opposed to previous math classes where I never had the chance to say what I was thinking.

Similarly, Mark explained that his teacher's questioning techniques "enhance it [his ability] because, in a way I'm stimulated to use my ability to perform at math." Johanna also described an increase in her self-efficacy, because she feels reassured when she sees that other students make mistakes as well. Johanna indicated that this makes her more willing to participate when her teacher is asking questions. She also felt like she could ask questions if she did not understand without "standing out as much." Johanna noticed an increase in her confidence due to the way her teacher's questions explored her

thinking. She explained it increases her confidence when she is able to work through problems together in class discussions, stating:

She'll put a question on the board and then she'll ask people, "what do you think the word problem is? What do you have to find? What are the key parts of the questions?" So it's like a word problem and it gives you the height, the length, and the width and then you pick it out and you have to tell her the formula. ... When you are putting your ideas together and then she's like you are right or something, then it kind of boosts your confidence.

Holly also expressed a similar experience, because she believed that the way her teacher asked questions enabled her to combine her ideas with peers to achieve the complete understanding of a topic. She perceived that this opportunity to combine ideas increases her confidence in her ability. Questioning techniques was the formative assessment strategy identified by Martin to have the greatest positive impact on his self-efficacy.

Some student participants found the implementation of questioning techniques to have a negative or neutral impact. John described questioning techniques and classroom discussions to not motivate him. He described having no motivation to participate in classroom discussions when his teacher is implementing questioning techniques, as noted by the statement:

Most of the time, I think correctly what the teacher is trying to ask. Like I don't actually give the answer, but in the mind I think about the answer. ... Like some of the other students say it, like that's not exactly what I was thinking but I didn't really say it.

Mark stressed the negative impact questioning techniques could have on a student's motivation if he or she was often incorrect, stating that "if I get shot down a lot, a lot of times yeah, it would affect my motivation. But once or twice and you are really close to the answer then no, it doesn't affect my motivation at all." Because Mark appeared to rarely get questions wrong when he contributed to class discussions, he did not believe that the use of questioning techniques negatively impacted his motivation. Similarly, Holly warned:

If I was to tell a teacher, what's one thing that kind of kills my motivation, is when the teacher tells me that my answer is completely wrong or I am not doing it the right way at all. It's to know that even if I am wrong, what I was thinking is somewhat close to the answer.

Similarly, Sarah also indicated that she felt less motivated when the teacher is implementing questioning techniques and she does not know the answer. Johanna also discussed a lack of motivation to participate if she felt her teacher was asking questions "to bother" or "to pick" on her. Some student participants expressed negative and neutral perceptions of questioning techniques that are not just focused on the correct answer, but rather for exploring student thinking. For example John stated, "I like being right, like I don't like being wrong. ... It doesn't really motivate me that much if I was thinking the wrong thing whereas the teacher could have told you what to think about at first." He also explained, "It would be better if the teacher told me the right answer first before we need to guess ... how to solve the question." Similarly, Mark stated:

I'm actually kind of neutral about that because either way, there is an answer that would be considered fully correct, right? Even if it is about thinking, there is not just one answer. There are multiple answers that are all considered fully correct. Mark expressed a lack of impact on his motivation when it did not matter whether or not he had the correct answer.

Student participants also addressed negative impacts of the use of questioning techniques on self-efficacy. Sarah discussed a decrease in confidence in her ability when her teacher is implementing questioning techniques as follows:

Class discussions ... they make me more hesitant. Like even though I am hearing a lot of answers from students and I am sort of being encouraged to do better in math, but I am also more hesitant, like I question my ability.

As previously discussed, one reason Sarah feels this way is because she does not feel "in control of things anymore" when the teacher is questioning. John and Johanna also described a decreased self-efficacy when others know the answer and they do not. Johanna explained, "that's the only thing that doesn't make me feel confident: is that if someone else gets it and I just don't. I don't feel like I should ask."

This theme addresses student participants' perceptions of the impact the use of questioning techniques has on motivation and self-efficacy. Many participants described the use of questioning techniques to positively impact their motivation. This impact can be attributed to the teacher participants' use of prompting and questioning with the purpose of exploring student thinking and when this strategy helps them to observe peers being successful. In contrast, some student participants described a negative impact on motivation when they are often incorrect, if the teacher states their response is completely

incorrect, or if they believe the teacher is asking questions “to pick” on them. Some participants described the use of questioning techniques to have a neutral impact on their motivation when questions are not focused on the correct answer, but rather explore student thinking. Student participants also described a positive impact on their self-efficacy, because the use of questioning techniques helps students to focus on the important aspects of a topic, to learn from their mistakes, to feel comfortable asking questions, to share their thinking and knowledge with peers, to understand that peers also make mistakes, and to work through problems together during discussions. Conversely, some student participants highlighted that questioning techniques negatively impact their self-efficacy when they do not know the answers to questions, particularly when either they believe the teacher is expecting them to know the answer or when peers are able to answer questions that they are not.

Feedback without grades. This theme highlights the impact of the use of feedback without grades on student participants’ motivation and self-efficacy. Participants highlighted some positive impacts of the strategy feedback without grades. Student participants addressed the increase in their motivation as a result of the feedback without grades that the teacher participants provided. Some participants discussed the motivation from written feedback on assessments. Kim stated, “for my mistakes, I like it when she gives me detailed feedback better [than just marks] because it motivates me and it teaches me what I did wrong.” Similarly, Johanna describes feedback without grades to be motivational because it provides her with direction, as suggested by her statement:

When she gives us like detailed feedback on what we did and on how we can improve...that makes me a lot more motivated, because then I can figure out what

I did wrong ... and since she's the teacher, she's not going to give me iffy answers. So she's gonna give me the right answers and she's like, "oh you need to fix this because you're calculating the slope, that's wrong and you forgot $y=mx+b$, it's not like that."

Similarly, Holly perceived feedback to be motivational, because it provides direction to focus efforts to improve. She stated, "so to me, if I just know what I need to do, I will certainly go do it ... when I get really detailed feedback." Holly also explained:

It really does [increase motivation], because to me when I get that kind of feedback ... when I know this is what I'm doing bad in and ok, I can totally fix this. It's not even hard. It's so much easier to go about doing my homework and having the motivation to do my homework. Because it's not like overall, I just did bad in everything. It's like this is the one thing, if you can just fix it, you are doing fine. That's what I really like about that feedback.

Holly described her teacher's feedback to be the "bump" she needs to be motivated, stating:

Motivation I think I get it from the teacher and I get it from the mark I'm getting in the course. Because if I'm really close to what I want to attain, I can do whatever I can to get it. But when I'm really, really far off from it, I need that little bump from my teacher to be like oh no, if you do this, you have so many more opportunities to do well. That little bump makes me go, okay I'm motivated, I should do this.

Mark discussed a positive impact on his motivation when his teacher provides him with an understanding of how to improve, as exemplified by his claim that "if the teacher

writes feedback about why you made this mistake ... it's good because then I can understand how I made the mistake and how I can better myself to not make this mistake in the future." Kim also explained, "I learn a lot from both [feedback without grades and self-assessment] and it encourages me to do better because I feel that I am more capable." Interesting to note, it appears that Holly and Kim describe feedback without grades to motivate them because it increases their self-efficacy by making them feel they are capable of succeeding. Martin also described feedback without grades as "positive criticism" and claimed it to be motivational.

Student participants also discussed individualized and general feedback without grades. Sarah preferred individualized feedback. She stated, "If she just says it to me or actually if she says it to me personally, then I feel more motivated." She explained this feedback motivated her because feedback without grades provides a connection between the student and teacher. She explained:

She [the teacher] goes and gives nice comments and good feedback. ... One day she came to me and she's like, "oh, what happened here?" Because on one quiz I got it perfect and on the other I just like flopped, I don't know. So I guess that's what makes us feel connected with the teacher as students and motivates us to do better in math.

In contrast to Sarah, John preferred general feedback to the entire class, as suggested by his statement:

If she gave the feedback in general, it would be more helpful, but if she only aimed it at me, I wouldn't be motivated to do it. But if it was in general, everyone would be doing it. If I could see other people do it, I would do it as well.

Important to note, John noted that time must be provided to improve based upon the teacher's feedback. He stated, "If I was given time to improve, I would consider it but if there is maybe an assessment the very next day, I wouldn't be more motivated to consider the feedback." Kim, Johanna, Sarah, and Mark all identified feedback without grades to be the most motivational formative assessment strategy.

In regards to self-efficacy, it appears that student participants found feedback without grades to have a positive impact. Martin claimed that "feedback is everything." He explained, "If you are doing well and receiving feedback, you can progress upon the feedback and do a lot better and do well in math in the end." Kim described the increase in confidence that her teacher's feedback provides her as follows, "I understand more. So for example, if I did something right, I know that I did it right because usually I am unsure about everything." She often referred to her teacher's detailed feedback as something that helped her "feel more reassured and confident about my work." Similarly, Sarah explains that her teacher's written feedback makes her feel more confident in her ability.

Student participants also described feedback without grades to increase their confidence in their ability because they know what they need to improve on. For example Sarah stated, "the detailed feedback I feel is a great learning opportunity and it definitely does better my ability to do well on the same question next time." Interesting to note, Sarah explained that personalized feedback without grades on her work makes the topic she is studying seem "more approachable." Similarly John stated, "I'll think that I can do better at this if I follow the teacher's steps, the feedback." It seemed that feedback improved John's confidence if the feedback made note of mistakes that are easy to

correct and improve upon. Holly also stated that detailed feedback “makes me feel a lot more confident to do my work, because then I know what I’m not doing so well in.” Kim added she felt more confident in her ability because feedback “made me understand it [the work] more so I could do the other, similar questions.” Similarly Johanna expressed she felt more confident in her ability because, “when I know what part is wrong and then I look at it and then I fix it. I’m like oh, it was a stupid mistake. I wasn’t focused enough, but I do know how to do it.” Similarly, Mark explained that feedback without grades improved his belief in his ability to be successful because, “if you can review that feedback, understand what they are trying to say to you, what’s wrong, then you have a much better chance of bettering yourself and doing better in that course.” Some student participants also indicated that feedback without grades helped them feel more confident in their ability as it helps them realize that not all of their work is incorrect. Johanna stated, “It [feedback] lets me know well, I can do it. I’m not dumb, I can do it. And so it’s easier.” Similarly Holly explained, “Knowing that if I can just fix a few errors...to know that I’m not horrible overall in math, I’m just kind of weak in one thing that I can easily fix; it makes me feel a lot better.” The student participants Kim and Mark described feedback without grades to be the formative assessment strategy that increased their self-efficacy the most.

Not many student participants discussed negative outcomes of feedback without grades. John stated that he believed feedback did not impact his motivation as he often did not work to improve based on his teacher’s feedback. Mark stated that feedback without grades did not impact his motivation, because he considered himself “always motivated to do math.” When discussing verbal feedback without grades, Johanna stated,

“it depends how it’s said, but it would either motivate me or get me angry.” If she felt the verbal feedback was “putting me on the spot and it’s like negative,” she found it to negatively impact her motivation. In regards to self-efficacy, Sarah explained that when her teacher provides verbal feedback to the entire class, her self-efficacy decreases, stating:

Like when we have quizzes for example, a lot of people do badly and then the teacher would address it. ... Then that makes me feel like oh, I don’t know, hesitant sort of ... I would rather not know that a lot of people are doing as bad as me or bad as a class. I’d rather know that there are people who know what they are doing so I know I am more encouraged to do better in the course.

She further explained this caused her to “form a judgement that this [the topic] is hard” and she did not feel hopeful that she could be successful.

This theme addressed the impact of feedback without grades on student participants’ motivation and self-efficacy. The perceptions of participants appear to indicate that feedback without grades increases motivation, because students are provided with an understanding of what they did wrong and what they can do to improve. Moreover, student participants perceived their motivation to be increased because they felt more capable as a result of feedback helping them understand that they did not do everything wrong. In contrast, some student participants perceived feedback without grades to negatively impact their motivation if feedback was phrased negatively. Some participants also indicated that feedback without grades did not have an impact on their motivation either because they were already highly motivated or because they did not work on the feedback provided. Feedback without grades seemed to positively impact participants’ self-efficacy, because it helped them to understand what they need to

improve on which consequently improved their understanding. In addition, feedback without grades increased participants' self-efficacy because it reassured them that despite having made some errors, not all of their work was incorrect and, in fact, ensured them they were on the right track. Some participants suggested that feedback without grades could negatively impact their self-efficacy if the teacher provides feedback to the class about common errors. This feedback seemed to cause some participants to perceive the topic to be too difficult and therefore their self-efficacy is negatively impacted.

Self-assessment. Student participants described the impact of the implementation of self-assessment on their motivation and self-efficacy. Several student participants highlighted that self-assessment increases their motivation to do mathematics. Mark believed that self-assessment increases his motivation, because he is able to see his progress. He explained, "If you document all of it, you can observe your progress and you can be like awesome, I am doing really great ... it increases my motivation." When discussing the Functionner's Book he stated, "It shows me that I have progressed to a higher level, a higher understanding of math and it definitely motivates me." Mark also described self-assessment that involves documenting growth over several years:

If you document it, you can observe how you change from let's say Grade 9, which is linear functions which is $y=x$, to Grade 12 or Grade 11, which is like $y=\sin x$. And you are like, wow I can do that now.

Martin explained why self-assessment increased his motivation as follows: "because everyone wants to be as perfect as possible, so you just want to keep progressing. It makes you feel good. You just want to keep putting in a lot of effort into it." Similarly, Kim stated that "it just encourages me to do better and it helps me understand so much

better.” She continued to claim that self-assessment made her more motivated, because “I can monitor what I am capable of doing and with my teacher’s help, I can improve on it.” Johanna described self-assessment to be a source of motivation when the process helps her to realize what she is doing wrong and if the errors are something she can improve on. She stated:

Because it makes me like want to do better ... because I know I can do it. So if I know I can do it, I’m making a simple mistake, then it’s easier to correct. And well I know I can do that part and I just need to remember to do that. So it gives me something to remember.

Holly addressed how self-assessment can have a positive impact on motivation depending on the student’s perspective as follows:

I guess that’s how self-evaluation helps. As long as you tell yourself you did everything you could, you just have to do better next time, it’s good. But if you self-assess yourself in a bad way and I know personally, it impacts me a lot, because then I’ll completely lose motivation to do the work at all and I’ll just put it aside. I’ll be like okay, I’d rather focus on something I’m doing well in.

It appears that if a student has a negative perspective when participating in self-assessment, their motivation will negatively be impacted. Kim identified self-assessment, in combination with feedback without grades, to be one of the most motivational strategies.

Student participants also addressed the positive outcomes of self-assessment on self-efficacy. Several participants indicated that their confidence in their ability to do mathematics was increased as a result of self-assessment because they are able to identify

what they need to do to improve. For example, Sarah claimed, “I feel more capable to do well on the exam because if I evaluate everything, I see like all my weaknesses, all my strengths, and I am more confident going into the exam if I work on those.” She further described the process she goes through with self-assessment as follows: “you are just alone with yourself and you get to like find your weaknesses and your strengths and kind of guide yourself ... and think about your choices and your options and what you can do to improve.” Similarly Kim stated that self-assessment increased her confidence because, “it gives me practice for the major tests so I feel more confident when I get the actual test, because I know I have practiced.” Kim is referring to the process of self-assessment she goes through when completing homework which, as previously discussed, several participants considered to be self-assessment. She also stated, “I feel like I am capable of doing more.” Johanna explained self-assessment made her feel capable when she believed she was making small mistakes that she could improve on, stating, “because then I know I’m able to do it like everybody else.” Some student participants also discussed an increase in confidence in their ability as they are able to track their progress through self-assessment. For example Martin stated, “It makes me feel a lot better than for instance, then I would be doing in math a month before. Because again, I am progressing.” Interesting to note, it appears that because Johanna had a low self-efficacy, she preferred self-assessment over other formative assessment strategies as it was personal. She explained, “I’d rather do it myself so that way they [peers and teachers] would not think I’m dumb.” She further commented on why she felt more confident in her ability through self-assessment, stating that:

I look at it [her work] and I see okay, well I did this right and this is done properly and then it kind of pushes me. Like if I make a mistake, I kind of press myself to get it right so next time I know I won't make the same mistake.

Johanna and Sarah identified self-assessment to be the formative assessment strategy that increased their self-efficacy the most.

It appears that student participants did not perceive self-assessment to have many negative outcomes. Student participants perceived self-assessment to negatively impact motivation and self-efficacy when they examine their progress, determine what steps need to be taken to improve, and after investing the effort still do poorly on a subsequent assessment. Holly described this to “kill your motivation and confidence.” John noted that when he attempts to self-assess himself and then focus on the areas that require improvements, other areas suffer, as suggested by his statement, “if I practice more on the things that I don't do well, I tend to forget the things that I do well. So it's kind of the opposite thing, where I can't even do the opposite thing.”

This theme addresses the impact of self-assessment on student participants' motivation and self-efficacy. Participants perceive motivation to be positively impacted because self-assessment activities help participants to determine what they are doing wrong, to identify next steps in learning, and to document their growth. Similarly, participants perceive self-assessment to positively impact their self-efficacy because they are able to track their progress and understand that they are capable of improving. In addition, self-assessment increases self-efficacy because student participants are able to identify what they need to improve on and are therefore more confident in their ability to be successful for subsequent assessments. Some student participants indicated that self-

assessment can negatively impact their motivation and self-efficacy when they do poorly on assessments after investing in the effort to improve on the gaps in their understanding that the self-assessment process identified.

Peer assessment. The impact of the use of peer assessment was discussed by student participants. Student participants described positive outcomes associated with this formative assessment strategy. Analysis of data indicated that student participants appeared to find peer assessment motivational. Johanna described it to be “more fun” while Sarah indicated that “I feel excited to be working with my groups and ... more challenged. There is a challenge to take and we are all kind of motivated to take it.” Martin highlighted that “I like teaching people, I like helping people out. It’s definitely motivational.” Sarah also explained that when her peers are providing her with feedback in peer assessment it made her motivated because, “I feel like I should do better.” She also explained that she feels more motivated when providing peers with feedback only if she knows the answer “or if I am more confident in my abilities to give them feedback.” John felt that if he had to select, peer assessment would be the strategy that increased his motivation the most. He claimed this was because:

We get to talk to other people and listen to what they think...Most of the time my classmates would do better than me so I’ll be more motivated to want to have that feeling when you’re doing better than someone else.

It appears that peer assessment positively impacts students’ self-efficacy, because their understanding is increased through the use of this strategy. In reference to gallery walks, Kim stated, “usually, the groups they have answered it differently. So ... I can see how they saw it in their perspective and it makes me understand the question better.”

When asked how this affected her confidence in her ability to do mathematics she explained, “I learn from their answers so I look at it and I can see from my answer, what I could improve on and what I did the same.” Johanna also indicated that peer assessment activities made her feel more confident because she was able to work on the problems herself and learn from mistakes. She explained:

Because then I see mistakes and then I see how to correct them. So it’s easier for me to remember because I’m doing it. So it’s easier for when I do things, I remember them more than when I see them. Like if I just look at something at the board I forget about it, but if I’m doing it and then I see the mistake I made or we made, then we correct it. Then it’s easier. Then it sticks to me more.

Some student participants also indicated that peer assessment increased their self-efficacy as they were able to help others learn. Martin stated, “If you teach someone, you are actually learning yourself. You are learning more for yourself. So the more I teach students, it makes me ... better at math just in general.” Similarly Mark explained how he feels when he is providing peers with feedback, stating that “it definitely enhances my ability and my mentality about doing math, because I am helping a person to do better, using my own skills to do that. So it kind of verifies my skills as well.” He further explained:

Well it makes me feel good because I’m helping them learn, I learn myself. Okay, well say they made a mistake in one of their questions. I’m like, well you made a mistake. Here’s what you should have done. Good, I can notice that I am also helping other students.

As previously discussed, some student participants interpreted peer collaboration to be a form of peer assessment. Holly claimed that peer collaboration increases her confidence in her ability as she is able to discuss with peers her thoughts before contributing to a class discussion. She suggested:

At least in my group I have noticed that if we are thinking of something and we can say it out loud, one of us will be able to point out something that is right and wrong in the answer. It just helps to make you feel a lot more confident to answer the question.

Holly claimed that peer assessment also made her feel more confident because she is able to see that others are also approaching problems in a different way, as indicated by her statement:

So getting to sit down and talk to everybody around me and know that maybe I'm not the only one who is thinking about it in a different way. It made me feel a lot more confident so that is one thing I really liked about the class.

She also added, "It kind of helps my self-esteem to be like okay, I'm not the only one thinking of it like this." Holly identified this to be the strategy that impacted her self-efficacy the most.

In regards to the negative impacts of peer assessment, student participants' responses seemed to focus on self-efficacy as opposed to motivation. Sarah highlighted how she feels if she is not confident in the material as follows: "if they are giving me the feedback, then I feel weaker." Sarah also explained that it depends on the material used for peer assessment whether or not she found it to have a positive or negative impact. She stated:

It depends what the teacher gives you to work on. Like if it's something you are familiar with as a class then yeah, you are good. But if you are not, if it's something hard and you are not sure, then it's not really. Like there is no point.

Johanna expressed similar sentiments of perceiving peer assessment to be a negative activity if the focus was a topic that she struggled with. She also explained that she did not feel confident in providing peers with feedback if she was not confident in the material, stating that "because if I'm struggling, then I don't like pinpointing [other peoples' mistakes] because then I start to ramble, then I look stupid." Holly cautioned that with a great deal of peer collaboration occurring in her class, she worried about becoming too dependent on peers. She claimed:

At times as an individual, even when I'm doing homework, I'm like great, I don't know if I'm doing this right. I don't want to be dependent on the people in my group. That's the only thing that the groups, it's a bad thing.

Holly feared the implications that too much peer collaboration could have on her level of understanding.

This theme highlights the perceptions of student participants that suggest peer assessment positively impacts motivation and self-efficacy. Participants' motivation is increased when they receive feedback from peers. Moreover, participants indicated that they are motivated by the success of peers, which they observed during peer assessment activities. Peer assessment also appears to increase motivation because participants are more challenged and find it enjoyable to work in groups. Student participants perceive a positive impact on self-efficacy because their understanding is increased, they are able to see different approaches to problems, and they are able to learn from peers. In addition,

participants perceived peer assessment to increase self-efficacy when they are able to help others learn. Important to note, some participants discussed that peer assessment negatively impacts their self-efficacy when they are not confident in the concepts that the activities focus on.

Formative use of summative assessment. This theme addresses the impact of the formative use of summative assessment on the motivation and self-efficacy of student participants. Student participants highlighted the positive impacts of the formative use of summative assessments on their motivation. Kim highlighted how the implementation of this strategy impacted her stating:

Looking back at what I did right and what I did wrong, it motivates me more ... because I know what I did right so I know my strengths and then for the weaknesses, now I know what I did wrong and how I can improve on it.

Similarly Johanna stated:

Because then I'd know, okay well I don't have it this time, but next time if I remember this, because she told me I need to work on this, then I get something to work on so I don't make the same mistake again.

It appears that participants perceived the implementation of this strategy to positively impact their motivation because they are made aware of what areas they need to improve on. Martin also discussed similar sentiments, as indicated by his statement, "motivation obviously increases because it's like another opportunity to improve. ... So, it motivates me to do better because I know that on the exam I will get that question right if I practice it or the weakness." He explained further:

I would probably say after Ms. Kara gives us a test back, that is probably the most motivational part, because I am trying to do really well in school. I am trying to get a really good mark and that is basically all I am focusing on. So I will do everything to improve that mark, because that is the point ... whenever I get a test back that's an opportunity to become better and that is what I want to do. So every single time I come to class, I try to do as much work as possible which will build up to that test and then when I receive that test back; again it's another opportunity for me to get better on the exam. So that is really motivational for me.

As previously discussed, some student participants interpreted the formative quizzes implemented by their teachers to be the formative use of summative assessments. Mark described these quizzes to be motivational because, "all the questions from the formative assessments will be in some way, some form on summative assessment which gives me an edge so to speak." Holly also explained, "doing the quizzes ... it makes me more motivated to stay on top of my work and that's the only way that I personally can do well in math is if I stay on top of all my work." As discussed under the theme of the diverse interpretation of formative assessment strategies, student participants from School A perceived practice tests to be the formative use of summative assessments. Martin found that practice tests increase his motivation and he explained:

[What makes me] most motivated would probably be the practice test that we do in class. It is very helpful ... at the end and it's a good opportunity to see how well you do on it. Because if you do really bad on the practice test, you know that you have to go home, study, study, study, do extra questions. Do whatever it takes to do well on that final test.

Martin and Mark both identified the formative use of summative assessments to be the strategy that impacted their motivation the most.

It seems that the formative use of summative assessments increased some student participants' self-efficacy, because they are able to improve upon the gaps in their understanding. For example, Sarah stated that "I feel more confident going into another evaluation so if I see that ... she comments on my form and I see what I am missing, then I will fix my mistakes on another evaluation that is coming." Sarah also explained:

Every quiz and every test is like a summary of everything you've learned. So if you just gather that, you can kind of evaluate your weaknesses and strengths.

Then you work on your weaknesses and then you just like remember what you were strong in and remind yourself of everything.

Similarly, Martin highlighted that he felt more confident in his ability to be successful when he was able to improve upon errors he made on summative assessments as noted by his statement:

It does [make me feel more confident], because there is always that one weak question and I know if I can get it, that means I am very thorough through the unit. I know how to do all the problems. ... The final exam I believe is like, the last chance to do well. So if you improve from your tests, then you do really well on it.

Kim and Holly described similar sentiments. Kim explained that she had an increased confidence in her ability, because she was able to "learn more" and "know how to do it better the next time." Holly explained that her confidence in her ability to do well in mathematics increased because, "it helps me understand what I'm weak in or not. ...

Even if I'm doing really badly in math, it's like at least I know what I need to improve on." Because Holly classified the formative quizzes implemented in her class as the formative use of summative assessments, the positive impact they had on her self-efficacy is discussed here. She claimed that it was in this class that she learned about the difference between formative and summative. She stated that before, "I had actually no idea that we had formative and summative is the other one. So when she first told me, I was just in complete shock, because I didn't know the quizzes were just there to help us." She explained how the quizzes impacted her self-efficacy as follows:

In all my [previous] math courses, you did your lessons and then you had this one big test. It's just your entire mark. You wouldn't know what things you are weak in and what things you're not weak in. You're doing your homework alone. So when I got the test back I realized oh, I didn't do well in this. If I knew I didn't do well on this in the first place, I would have focused more on that. So that's how I prepared myself with my quizzes. They help me know what I should be more confident in and what I shouldn't be more confident in.

Holly found the formative use of summative assessments to increase her self-efficacy the most.

A few student participants highlighted negative outcomes of the formative use of summative assessments. John stated that if his marked tests "are like really low, like I just don't really want to look at it. It loses my motivation to do math." He also indicated that in regards to formative quizzes, he did not find that they increased his motivation because they were not for marks. In regards to self-efficacy, Sarah explained that reviewing

marked summative tests can make some students feel discouraged if they do not do well and “they sort of question their ability.”

This theme highlights the perceptions of student participants on the impact of the formative use of summative assessments. Participants perceived this formative assessment strategy to positively impact their motivation primarily because they become aware of what they know as well as what they need to improve on. Motivation is also increased, because this strategy presents another opportunity for students to improve. Similarly, participants perceived self-efficacy to be positively impacted because participants are able to improve on gaps in their understanding and they know how to do better for subsequent assessments. Some participants did highlight that this strategy can negatively impact their motivation and self-efficacy if they do very poorly on the summative assessment.

This section addresses the perceptions of student participants in regards to the impact of formative assessment strategies on the motivation and self-efficacy of mathematics students. This section first highlighted the overall themes that emerged including the interpretation of motivation and self-efficacy, the sources of student motivation and self-efficacy, the connection between motivation and self-efficacy, peer and teacher judgement, and the perceptions of mistakes. Second, this section addressed the impacts specific to each formative assessment strategy including the positive impacts and the negative or neutral impacts some participants noted. The subsequent sections will address the themes that emerged based on the perceptions of teacher participants.

Themes Based on Teachers' Perceptions

The analysis of data gained from teacher participants' interviews revealed six overarching themes, which are organized based on the study's research questions. Under the topic of the implementation of formative assessment, the themes include (a) the influence of the teacher, (b) theory in practice, (c) the interconnectedness of strategies, and (d) the support and barriers to implementation. The themes concerning the impact of formative assessment on student self-efficacy and motivation are (a) formative assessment as an opportunity to "get it" and (b) the "diverse cliental of learners." These themes address the perceptions of teacher participants on the implementation as well as impact on self-efficacy and motivation.

Ways in which formative assessment is implemented. The teacher participants presented data that led to four themes being formed under the topic of the implementation of formative assessment. The themes consist of the influence of the teacher, theory in practice, the interconnectedness of strategies, and the support and barriers to implementation.

Influence of the teacher. The main topics that are discussed within the theme of the influence of teacher include teachers' personal philosophies, interpretation of ministry documents, and experiences.

Teachers' personal philosophies. Both teacher participants had personal teaching philosophies, which impacted their implementation of formative assessment strategies in their classrooms. It appeared that both teacher participants had a strong teaching pedagogy, which included the belief in the importance of formative assessment. Beth's philosophy was that it is the role of the teacher to offer guidance as opposed to

evaluation, as noted by her statement, “you’re a teacher and it’s about teaching. Assessment is part of your job as a teacher. You are not an evaluator, you’re a teacher. This [formative assessment] is for teaching purposes.” This perspective influenced her desire to implement formative assessment strategies in her mathematics classrooms, as exemplified by her claim:

[Formative assessment] is teacher offering guidance rather than offering an evaluation with your first shot. This is your first and only shot and that is what it’s worth. ... This is guidance to help students improve. It was brilliant so I thought this is the way I want to be as a teacher.

Analysis of data suggested that teacher participants’ strong teaching pedagogy and sense of self as teachers helped to make the implementation of formative assessment in their classrooms possible. Kara described:

Once I developed a strong self as a teacher, I came to this school that is not nearly as progressive or informed of proper assessment [as previous school]. ... I feel like I am now strong enough that I can for sure advocate it [formative assessment] for my own students and regardless of what other people are doing, I will demand that I do the right thing for mine, but then I can also start to share it with other teachers.

Furthermore, it appeared that teacher participants’ philosophies also impacted how they implemented the strategies in practice and which strategies they placed more emphasis on. Kara’s philosophy was that teachers must make mathematics engaging and fun, stating: “That is sort of our job I think as teachers; we are entertainers. We are trying to make this as engaging and as fun as possible.” It seemed that this philosophy led her to

focus on providing detailed feedback without grades through interactive games. Kara explained:

The little interactive games after the lesson is taught, sort of that consolidation piece. ... Finding fun and engaging ways to see if they know. It is just a matter of being creative. Soon as you start doing them with the students and you see how much fun they are having and how much they are learning, then it is easy to keep motivated to do it.

Beth placed a lot of importance on peer collaboration, which resulted in an emphasis on the use of peer assessment activities in her classroom, as suggested by her statement:

There's a lot of peer assessment formative assessment in my class, because they work in groups of four and they're constantly talking to each other about problems. ... I think that's way more powerful than getting information from me.

Teacher participants' personal philosophies promoted the implementation of formative assessment strategies within their classrooms.

Interpretation of policy documents. The interpretation of Ministry of Education documents impacted the assessment practices of teacher participants. Both participants referred to the policy document *Growing Success* (Ontario Ministry of Education, 2010).

Kara stressed how this document encouraged formative assessment as follows:

Growing Success, our assessment policy, it encourages formative assessment, but it says that it's not meant to be part of their report card mark. So I believe that if the Ministry of Education that is sort of our strongest and best leaders has determined that is what is best for students, then that's what we should be doing.

Similarly Beth highlighted the value she saw in the guidelines presented in the document, stating, “*Growing Success*, it makes sense. You want to give students the opportunity to do the best they can, not on October 10th, but throughout the course.” Kara also described the implementation of feedback that is not for marks in her classroom based on the policy document, stating:

So *Growing Success* ... it says that only summative assessments can count towards their final report card mark. You have probably heard the mention of most recent, most consistent in terms of assessment and so that is really what it means. I might give quizzes throughout the unit, but the most recent assessment, that final assessment piece is what counts towards their mark.

Kara also referenced the curriculum documents, which influenced her use of formative assessment strategies, as suggested by her statement:

Since when the curriculum, the learning expectations, changed and we became about self-regulation, it’s also about getting the students themselves to be able to ascertain do they understand a concept and if they don’t, how do they go about figuring things out and sort of advocating for themselves and learning for themselves. That I think is another big piece of formative assessment.

This emphasis on self-regulation further encouraged Kara’s implementation of the formative assessment strategy of self-assessment in her mathematics classroom. This emphasis is represented within the Ontario mathematics curriculum in the form of the mathematical process expectations (Ontario Ministry of Education, 2005, 2007). The seven mathematical process expectations “describe a set of skills that support lifelong learning in mathematics and that students need to develop on an ongoing basis, as they

work to achieve the expectations outlined within each course” (Ontario Ministry of Education, 2007, p. 17). Self-regulation is represented within the expectation of “reflecting.” The emphasis on self-regulation that Kara pointed out is also reflected within the learning skills and work habits outlined in *Growing Success* where self-regulation is listed as a learning skill (Ontario Ministry of Education, 2010).

Consequently, the teacher participants’ interpretations of the Ministry of Education’s curriculum and assessment policy documents and the value they placed in following them facilitated the implementation of formative assessment in their practice.

Experiences. The analysis of data suggests that the experiences of teacher participants influenced their implementation of formative assessment strategies. Kara’s first years of teaching were at a school with strong and progressive assessment values, which led her to understand the importance of implementing formative assessment in her classroom. She explained:

I use to teach at a school that had very strong and progressive assessment values and so that was sort of the expectation among all the teachers. Now I just see the benefit of it in terms of giving students all those chances to show their understanding and to develop their learning. So when you see it in place and how it works, it just makes sense.

It seems that these experiences inspired her to implement formative assessment and to continue to do so even after moving to a mathematics department that placed less emphasis on formative assessment. Beth attributed the experience of being a parent to influence her to begin implementing formative assessment in her own practice. She observed her children’s teachers outside of mathematics provide feedback and then the

opportunity to improve their work based on the feedback. As a result of the benefit that she witnessed this process had for her children, she began implementing formative assessment, in particular the strategy of feedback without grades. The combined varied experiences of teacher participants contributed to them understanding the value of formative assessment and to begin implementing the strategies in practice.

The theme of the influence of the teacher describes the impact of teachers' personal philosophies, interpretation of policy documents, and experiences on the implementation of formative assessment strategies. Participants' strong teaching pedagogies and sense of self as teachers promoted the implementation of formative assessment within their classrooms. Moreover, their philosophies influenced which strategies they emphasised and how they implemented them in practice. The interpretations of the Ontario Ministry of Education policy documents, including assessment and curriculum documents, also facilitated the incorporation of formative assessment practices in their practice. In addition, their experiences such as teaching environments and being a parent, further promoted their implementation of formative assessment. These combined factors influenced teacher participants' belief in the importance of formative assessment strategies and facilitated the incorporation of strategies within their classrooms.

Theory in practice. Teacher participants discussed how they implemented formative assessment in their mathematics classrooms. This led to the theme of theory in practice, which is organized based on the five formative assessment strategies.

Questioning techniques. An integral part of both Kara and Beth's classroom structures is the use of classroom discussions. Within these discussions, they

implemented the use of questioning techniques to improve student understanding. Kara described framing questions to explore and develop student understanding, stating:

Everything is a discussion, everything is a question. So I would never give them a math problem and then do the solution. I would give them a math problem and then ask them those prompting and guiding questions to, as a class, work through the solution. And I find that keeps them engaged.

Both teacher participants discussed the use of prompting, a questioning technique, to elicit student understanding and potential gaps in learning. Beth also referred to the use of exit tickets at the end of class to develop a basis for the next lesson's discussion. Students are required to answer a question on a piece of paper, which they must hand in to the teacher as a ticket to leave class at the end of the period. Beth described, "I really want to be able to cluster their responses and say okay, well these are the different kinds of responses. What do you think? I'll take the answers up so that will be the opener for the next lesson." This organization of responses provides the opportunity for discussions to explore student understanding, while discussing important issues dealing with the mathematics topic. Similarly, Beth highlighted using student misconceptions as a topic for classroom discussions to further develop understanding and to explore important issues in achieving learning goals. For example, when discussing exponential growth and decay functions and the corresponding rate of change, students frequently made errors. Beth made this the topic of discussion in order to explore and develop student understanding.

Both teacher participants discussed the use of classroom discussions and questioning techniques when there is more than one right answer to a question. Beth

described the complexity of those discussions as follows: “Those are rich discussions. How come this one [solution] and this one [solution] are so different but they are both right? What’s going on? What was happening here that’s not happening here?” Similarly Kara described:

Having an understanding of often times in math there are different ways to come to the same conclusion. So having that discussion of here’s one question, three different students got three solutions, which one is the best if there is even a best method? Getting them to think critically about how they are working.

These classroom discussions are not aimed at getting a specific, correct answer, but rather to develop student understanding that there can be more than one correct answer. In order for questioning techniques to be successful in developing and improving understanding, it is necessary for students to be engaged in the discussions. Kara described the required classroom environment, explaining that “you have to develop an atmosphere where participation is encouraged and it’s demanded really that you have active, engaged students.” Teacher participants employed various questioning techniques, primarily through classroom discussions, to explore and develop student understanding and to identify potential gaps in understanding.

Feedback without grades. Descriptive feedback without grades played an important role in both classrooms. According to Beth, “with feedback you’re not just giving it back to them and saying ‘do a better job.’ You have given them sign posts, something to go look at. They can usually figure out some way to make it [their work] better.” Similarly, Kara described detailed feedback in the context of mathematics, claiming:

In math, the detail is in that the questions aren't necessarily right or wrong and when we assess, we don't really assess for right or wrong. It's an assessment of the process. ... But getting students to understand that and that is sort of the detailed feedback: what is the actual full solution, full understanding of that particular concept.

Beth explained feedback in mathematics to be a means of helping students make the connections they have seemed to not yet make. Kara highlighted the abundance of opportunities to provide feedback in mathematics, noting that "I think in math, we're really lucky that there is tons of feedback that we are able to offer students."

Both teacher participants implemented the use of quizzes to provide written, descriptive feedback on student understanding. Beth indicated she did "truckloads of quizzes" with a lot of written feedback. She claimed that "kids flip out when they first have me because there is so much writing on my quizzes." Students were aware that these quizzes were not for marks, but for the purpose of helping them become aware of and then correct gaps in their learning. Kara described:

They [students] know it's formative. They understand that it is assigned a mark and its being recorded, but that is not part of their report card grade because the assessment is meant to inform their own learning and my own learning.

Kara provided marks so students have an idea of their level of understanding; however, these marks are not summative and therefore are not included in final grades. Beth also discussed collecting class work to provide detailed feedback without grades for Grade 9 Applied students, stating, "the Grade 9 Applied: lots and lots and lots of formative feedback. Lots of just collecting class work and giving them feedback. ... So an awful lot

of that and that just keeps them moving forward really.” Important to note, Kara addressed the difficulty in providing detailed feedback to students, as suggested by her statement, “I think that detailed feedback is a challenge for teachers, because just in its nature it would take so much time and effort and we just don’t have that time in the day often.”

Teacher participants also described the use of verbal, detailed feedback. In Beth’s classroom, detailed feedback was specific to the student; however, when common errors were made, she discussed them as a class. She noted:

If I see a common problem you know across 50% of the class, then we will just talk about the problem. When I say the problem, the mistake that they’re making, not the question. ... It’s the bigger picture that I want to talk about.

Beth employed these discussions and verbal feedback to guide student understanding.

Kara discussed providing immediate and specific verbal feedback during class discussions as follows: “as you are learning things, you are giving them verbal feedback whenever they offer an answer.” Kara also portrayed classroom games as a way to provide students with immediate feedback while working on mathematics questions dealing with topics learned. She described the process:

I give them 20 questions one at a time using the Document Camera and it’s a race to see who can finish it and then who can explain their answer and they get points. ... It’s so much more fun and they are so much more engaged.

Kara explained further:

If I am doing that whiteboard game and they are all holding up their answers, I know the three or four kids who aren’t holding up whiteboards or they are holding

up the wrong answer all the time. So then I can say to them towards the end of the class by themselves quietly, “you weren’t really getting it today, why don’t you come after school? We have extra help in room 210.” And when we are doing that and they are holding up the whiteboard I am making eye contact. They know that I know that they don’t understand and they know that they don’t understand and so it is sort of creating that accountability.

Kara implemented games in order to gain an understanding of the level of student understanding, to provide immediate feedback, and to encourage students to come for extra help so they can be provided with the specific feedback necessary to improve. Teacher participants implemented feedback without grades by providing students with direction to improve their understanding through the use of both written and verbal feedback.

Self-assessment. Teacher participants implemented self-assessment in diverse ways with varied emphasis placed on this formative assessment strategy. One method Kara used to incorporate self-assessment in her classroom was to have students mark their own quizzes, which, in turn, involved them in the assessment process. After a formative quiz is completed, she works through how to solve each question and students are required to mark their quiz. She described how this strategy impacted students:

I find in getting them to mark their own, it really allows them to see if they’ve made a mistake, to then see how to correct it, how to do a problem completely. If I mark it myself and I just mark a big x and hand it back, they often say oh, I got it wrong and that’s it. But if they are looking through it and as I’m going through they see they got it wrong, they often will copy down the solution and they’ll

better understand how to actually answer that question because they are more involved in the assessment process.

It appears that Kara identified this activity to be self-assessment, because students become better aware of the learning goals and the metacognitive processes such as monitoring their own learning are promoted. Similarly, Kara encouraged self-assessment through challenging application or thinking questions. She indicated:

I'll give them ... a more challenging application, thinking question and ask them to solve it. Then we will go through it and talk about what are the criteria here for having a perfect or a strong answer. So we will kind of list out those criteria and then ask them to go back and assess what they would give themselves, what level they would assign themselves for their solution and then if it wasn't a level four, what would you now change ... and make those changes and show me that you now understand how to answer that question completely.

This implementation allows students to better understand the learning goals, to assess their own understanding, and to use their judgement of their work to improve. Kara also perceived homework to be an opportunity for self-assessment, as exemplified by her statement, "Every time they do their homework they are getting feedback, because they know hopefully themselves whether they can do it and they have the answers to check and see." She identified this process as students not being consciously aware that they are doing self-assessment, as suggested by her statement:

They may be at home doing their homework and realize that they don't understand it so they will ask those questions at the beginning of the next class.

That's formative assessment, that's self-assessment, but they might not know that that is what they are actually doing.

Similarly, Kara promoted students to monitor their own learning by having them rate their understanding of their homework, as indicated by her statement: "getting students to rate their understanding of their homework completion everyday so that the students are having to consciously be aware of how much they understand."

Beth perceived self-assessment as students being able to acknowledge their strengths and weaknesses, as suggested by her statement, "You [the students] have to know where your strengths are, that's self-assessment. Then you decide the things that they have to learn which is difficult again for high school students." It appeared that as a result of this perspective, one way Beth implemented self-assessment is by having students determine which question they are more capable of solving on formative quizzes and summative assessments. She explained, "Here are four problems, choose one. Do you know which one you know best? Self-assessment." She believed this was one way to stress self-assessment, stating, "Giving them choices just shines a spotlight on it [self-assessment]. Like a test, they should be able to look at any test and go to the questions that they know they can do with most confidence." She provided an example of this implementation on an assessment, which involved optimization as follows: "They don't need to be able to do every optimization problem ... they need to be able to show that they understand optimization as a concept and what the procedures are." Beth also outlined a quick incorporation of self-assessment through "thumbs up and down." During a lesson she would do a quick survey of student understanding by having students either put their thumb up if they are understanding the topic or conversely, thumbs down if they

are not. Beth employed self-assessment at the beginning of a course or unit when she found students are behind in their understanding. She provided students with gap closing materials found on the EduGAINS website, which is an Ontario Ministry of Education developed resource. She provided an example: “You’re really struggling with linear growing patterns and really you kind of need that down before we start doing this more abstract x, y stuff so here is some gap closing materials on the linear growing patterns.” She explained this is an implementation of self-assessment, stating:

They can check their own work against the materials that they are provided with and they can go back if they need to or move on if they feel confident. So they’re actually doing a little bit of metacognition. They are actually setting their own pace with your guidance as to what seemed to be their problems.

Students monitored their own learning with the goal of improving understanding.

Important to note, Beth addressed what she found to be the problem with implementing what she referred to as formal self-assessment. She stated:

The formal kind of self-assessment that I can picture ... the portfolio and they had to talk about their best work and their worst work. ...I don’t do it because I feel like they’re trained how to do it ... they did it all through elementary school and they know okay, this is my best work and the evidence that it was my best work, I got the highest mark. I feel like I’m getting pat response instead of real reflections. I think I’m getting what they think I want to see. So if I’m not getting honest reflection, I’d rather not get it at all.

It appeared that Beth perceived that formal self-assessment activities, such as the portfolio, do not encourage metacognitive processes with authentic reflections that can

improve student learning. As a result, she did not implement these types of activities in her classroom. Teacher participants had diverse implementations of self-assessment and each had a different emphasis on structured self-assessment activities within their classrooms.

Peer assessment. Both teacher participants found the implementation of peer assessment challenging. Beth explained:

The traditional peer assessment that you see in English class where they exchange papers and they give each other feedback, I haven't done a lot of that in math. ... Maybe I haven't figured it out so it doesn't make people uncomfortable. People are very embarrassed by hugely wrong work. So perhaps it needs to be done in a context ... where there are lots of right ways and lots of wrong ways and there are better ways and worse ways.

Beth noted a lack of exemplars of ways in which students exchange work to be assessed that has worked well in mathematics, as indicated by her statement, "Exchanging work has been difficult for me to implement myself and I haven't see anything that says to me this is the way to do it." Furthermore, Beth identified an overall lack of implementation of peer assessment in the mathematics community. Similarly, Kara addressed challenges with peer assessment, stating:

I find peer assessment kind of a challenge. ... If I give them quizzes, I never tell them to trade with someone around them, because I would hate for a student who did poorly to have to give that assessment to someone else. So I wouldn't say that I really use peer assessment very often.

Although judgement from peers impacted teacher participants' use of peer assessment, there were other ways they still incorporated this strategy within their classrooms.

In order to avoid issues of students feeling embarrassed by their work, teacher participants implemented strategies that they described to have "less jeopardy." One example is that both teacher participants implemented gallery walks. Beth explained how groups of students would work on a solution, which they would then write on a chart paper to be posted within the classroom. Students are then able to view the different solutions that other groups have come up with. Beth suggested why less jeopardy is involved, stating that:

Gallery walks are nice, because they are usually done by groups of students and so you are one of this anonymous bunch. ... They can put their names on the back of the chart paper and then nobody knows. ... So that has less jeopardy attached. ...

The kids have sticky notes and they can put their comments on each group's work. Beth added that when there is a day between completing the question and posting the solutions, if a solution has been done extremely incorrect, the teacher can choose to not post it so there is no need for comments. Similarly, Kara described gallery walks done with individual work when students are required to graph a function, stating:

Don't put your name on it, but everyone make a graph of whatever the situation is. Then we might put them all out on a table and then everyone go around with stickers and assess which one is the best. That way you are not choosing the exact person, you are choosing the work that is the best. ... We then just discuss okay, what is the criteria that made this one so good?

Beth highlighted that gallery walks work well with questions where there is not just one correct answer, as suggested by her statement:

Functions are a really good example. You give a bunch of criteria and you just watch how they attach those criteria in different ways. Some of them will start with trying to do it algebraically and others will start with graphing and five will come up with graphs and they will all be completely different, but they all meet the same set of criteria.

Beth found that with younger students this activity can be difficult as they may not have the ability to understand that all answers can be correct. With these students, she was inclined to do multiple step problems. Beth has incorporated peer assessment on graphic organizers at the end of a unit when no mark or overall assessment is provided. She explained:

You get the kids to do their own Frayer Model and then you [students] sit in a circle or oval and they just pass it around and you read what's there. You [the students] add anything that you didn't see before and then when you get yours back, you get to add anything onto yours that you can remember from the ones that went around. Then just seeing how much you had to add or was added. ...

That's a very gentle way of doing a peer assessment. It's not assigning a mark. It's giving feedback for the sake of learning.

These implementations of this assessment strategy emphasize how peer assessment is meant to improve student learning.

Within Kara's classroom, peer assessment is also incorporated when students discuss solutions to questions on their formative quizzes, as exemplified by her statement:

Giving students a quiz and then asking them with a partner to compare answers and with a partner, or a group of four, make sure that you all have the correct answers. Then you get in that dialogue. It's really neat to be able to walk around and hear them sort of dialoguing about why one answer is right and why one answer is wrong. ... It's amazing that they really are able to show some really strong understanding of the concepts and then being able to articulate that. You really do get the sense, and I think they get the sense, that they really do understand what they are doing.

Students are able to identify gaps in their learning and correct their own work based on the feedback provided by their peers. Similarly, Kara incorporated this activity with a single thinking or application question outside of a quiz. Kara has also implemented a snowball activity as a form of peer assessment, as noted by her statement:

I'll have them come up with questions and then they will share the questions with other people in the class. Other people will do the solutions and then we will hand that off to a third person who will then grade it.

She continued to explain why it's called a snowball activity, stating that:

Everybody writes a question. We crumple them up and we throw them in the middle. Everybody grabs a new one and they solve it, crumple it up, and throw it in the middle. Everybody grabs another one and then eventually you get your original one back. You see the solution that people made and the mark that they got.

This activity appeared to be a way in which peer assessment is implemented in the form of a classroom game.

Both teacher participants referred to peer teaching and peer collaboration on work as an implementation of peer assessment. Kara stated, “Peer teaching; they certainly help each other a lot in class with their homework and they are encouraged to ask each other questions. So then it’s like I have 30 teachers in the class, not just one.” Similarly, Beth discussed her Grade 9 Applied mathematics students passing on expertise as follows:

One person might be checking different pods [of students], “so did you get it?”

And then work with one person in that pod ... they would pass on the expertise to the one person they thought would get it and then they expected that person to explain to the other kids. Then they would go off to another table.

Beth described them to be “bouncing around like a bee among flowers just sharing their expertise with different groups of kids.” Both teacher participants highlighted the amount of peer collaboration that is encouraged within their classrooms. Beth noted, “They’re not just talking. They are seeing each other’s written work and they are commenting on each other’s written work.” Beth identified peer teaching and peer work as an “organic” form of peer assessment. Interesting to note, two classrooms at Beth’s school the following year were going to be dedicated to having students work collaboratively in groups throughout the semester.

Moreover, Beth discussed a peer assessment activity that was going to be implemented the following year at her school. Currently this activity was done to provide students with feedback from their teacher, but it was going to be expanded to incorporate peer assessment. Beth explained:

Students write up their slides [with different steps of their solution to a problem], but their slides are on paper which is why it's called paper slide. It's like PowerPoint except it's on paper and they just physically move the paper out of the way and put a new page on and somebody is holding the camera. ... They submitted it to the teacher and the teacher posted it on the [school board] site. So everybody could see everybody else's presentations. ... It's just like a gallery walk, except now it's posted on a site.

Students are able to verbally explain during the video what they did and why for each step to the solution. This strategy was being expanded to include the opportunity for students to comment and provide feedback on each group's work, thus involving peer assessment. Teacher participants identified the implementation of peer assessment to be a challenge because of concerns that students may fear judgement from peers or feel embarrassed by their work. However, teachers still found ways to implement this strategy through methods such as gallery walks, providing feedback on graphic organizers, snowball activities, peer teaching, and peer collaboration on work.

Formative use of summative assessments. Both teacher participants described the implementation of the formative use of summative assessments in different ways. Beth implemented this formative assessment strategy on class assignments. She provided students with feedback with or without a grade and then offered them the opportunity to improve their work, as indicated by her statement:

I give students who achieve below a level 3 a chance to do it over again. If a student achieves a level 3 or a level 4 and they want to tweak it, they're free to do

that, but I really encourage the kids who are just achieving below a level 3 to actually take the time and redo it.

She provided an example of when she found common problems across all assignments, stating, “I just handed one back. I didn’t mark any of them. I just said, I’m seeing this common problem and I think you can do better.” Students were given the opportunity to assess their errors and address them. Beth also provided similar opportunities during a 2-week Grade 11 project. The project was divided into five sections, which involved modelling a picture like a car or animal based on mathematical functions such as cubic, square root, reciprocal, or trigonometric functions. In each section of the project, the mathematical function increased in complexity. Students were provided the opportunity to improve their work throughout the process based on teacher feedback on each section, which improved their overall understanding of modelling functions.

In Kara’s classroom, practice tests are incorporated prior to a summative assessment, which she identified to be the formative use of summative assessments. She structured her course so that in each unit she had a practice test day, then a review day, and then the summative test. She outlined the implementation as follows, “We will take up the solutions the next day or I’ll post them online and the students have the opportunity to take a test, see how they have done, figure out things for themselves, then improve for the next day.” In applied courses, Kara described further implementation of this strategy, stating:

In an applied, I think that if they have the desire where they’re going to come for themselves ... to rewrite an assessment, then we should be fostering that, because

those applied students don't often make that effort. So I want to encourage it whenever they want to.

If students in applied classes demonstrated the initiative to want to improve on their summative assessments, Kara provided the opportunity for them to address their gaps in learning and complete the assessment again. The formative use of summative assessments was incorporated by teacher participants in diverse ways including practice tests as well as providing feedback and then the opportunity for students to improve their work on assignments or projects.

This theme addressed the various implementations of the five formative assessment strategies by teacher participants. Questioning techniques were implemented through the use of questioning and prompting during classroom discussions to explore, develop, and elicit gaps in student understanding. Teacher participants utilized various strategies including exit cards, the use of student misconceptions as a topic of discussion, and questions with multiple solutions. The strategy of feedback without grades played an important role within the classrooms of participants. Teacher participants provided written feedback on formative quizzes and on classroom work. Verbal feedback was incorporated to provide immediate and specific feedback during classroom discussions, games, and activities. Participants placed a varied emphasis on self-assessment within their practice. Some implementations involved students marking their own quizzes, working on challenging application or thinking questions, completing homework, rating their understanding of their homework, and making decisions on assessments of which questions they were more capable of solving. Teacher participants highlighted issues surrounding the implementation of peer assessment; however, still found ways to

incorporate this strategy successfully in their practice. Some examples of this include gallery walks, snowball activities, or peer teaching. The formative use of summative assessment was implemented by teacher participants primarily through practice tests and by providing students with feedback and the opportunity to improve their work on assignments and projects. Consequently, teacher participants implemented the five formative assessment strategies in practice using multiple methods and activities.

Interconnectedness of strategies. Analysis of data from teacher participants suggested that formative assessment strategies are interconnected. Teacher participants discussed the relationship between self-assessment and feedback without grades. Both participants highlighted how feedback without grades promotes or leads to self-assessment. Beth described providing feedback to encourage self-assessment, “We talk about learning from your mistakes. Even today I said it. You know when you are studying for your exam, you have to look at your mistakes.” Similarly, Kara explained how feedback leads to self-assessment; however, it is the responsibility of the student to make this connection. In particular, she provided the example of the whiteboard game used to provide students with feedback, stating:

They know that I know that they don’t understand and they know that they don’t understand and so it is sort of creating that accountability. ... We can show them the need and we can give them opportunities to figure that out for themselves, but we can’t do it all ... so formative assessment really allows them, gives them, the opportunity to be accountable for their learning and then to improve before it comes time to actually writing a test for marks.

Kara stressed that even though teacher feedback helps students become aware of their misconceptions, it does not mean that they will take the necessary steps to improve.

Teacher participants also discussed the connection between feedback without grades and questioning techniques implemented during classroom discussions. Both teacher participants highlighted providing students with verbal feedback when they offer answers or contribute ideas in groups. In Beth's opinion:

With conversation ... they are getting continuous feedback. You change something and you talk about it again and then you change something and you talk about it again. It's huge. It's got to be huge. It just makes sense that it's better than this one-way, dead end stuff.

Beth continued to explain:

It [classroom discussion] is just so much richer than well, you did this wrong, take it back. I don't know if you got it, I don't know if you understood it, I don't know if you cared, I don't know if you can fix it, I don't know if you know how to fix it, but in a discussion, all that evolves.

According to Beth, classroom discussion permits students to receive additional immediate feedback after improving based on the initial feedback provided.

Teacher participants highlighted the interconnectedness of the formative use of summative assessments, feedback without grades, and self-assessment. Beth identified one form of self-assessment to be when students reviewed feedback on marked assignments or tests. Students are expected to review the feedback to determine gaps in their learning and what steps can be taken to improve. Beth described what she tells her students as follows:

Your own personal mistakes, those are the things you are going to learn the most from. So as you are studying for your exam, don't go over the stuff that you got 95 on ... you got to study the stuff you got 40 on. That's where you focus your attention, because that is where you can see the most growth. That is where you are going to feel good.

Similarly, Kara discussed the use of practice tests in her classroom, which she identified as the formative use of summative assessments. After completing a practice test, students are provided with feedback during the discussion of solutions, which they are then able to use to ascertain how they have done and what they need to do to improve for the summative test. Students are then able to take the necessary steps to address their gaps in learning before completing the summative test. Beth's Grade 11 project described in previous sections also demonstrates the relationship among these strategies. As Beth stated, "You have to give them a chance to do it again, because if that's the end of it, what's the point of the feedback?"

Kara identified the connection between questioning techniques and self-assessment, which can occur depending on how classroom discussions are structured. Kara recounted a type of classroom discussion she has with students, stating:

We have this activity with EQAO where I give them an EQAO question and I give them four solutions and they have to figure out which one is a level one, two, three, and four. Then we talk about what makes a level four. If you were told to do something and you weren't given any criteria for how to do it well, you wouldn't necessarily know. But showing them the criteria, showing them examples of what is good and what is not, they can then see where they fit, but then also they can

see how to move up. You are just giving them the chance to have that understanding.

These classroom discussions provide students with the opportunity to self-assess, to determine deficiencies in their own understanding, and to ascertain how they can improve. This structured discussion provides students with an understanding of learning goals, which is necessary to effectively engage in self-assessment.

This theme addresses how the formative assessment strategies appear to be a set of interconnected strategies. Teacher participants discussed the interconnectedness of (a) self-assessment and feedback without grades, (b) feedback without grades and questioning techniques, (c) the formative use of summative assessment, feedback without grades, and self-assessment, and (d) questioning techniques and self-assessment. It appears the strategies are interconnected rather than a set of distinct strategies.

Support and barriers to implementation. Teacher participants outlined the various supports that facilitated the implementation of formative assessment strategies and the barriers which hindered its implementation.

Support. Both teacher participants indicated that strong leadership and teacher collaboration are essential to successfully implement formative assessment. Beth outlined the role her administration has played, stating that “My administration believes in it. That’s helpful. So if I’m doing things differently from other people, they’ll just say that I’m doing it right which is nice. It’s nice to have somebody backing you up. That’s very important.” Similarly Kara highlighted:

I think one of the hardest things is that teachers don’t necessarily understand how formative assessment works and the benefit to it and I don’t think that is

necessarily used effectively all the time and that really comes from strong leadership in an administration and in a department head or curriculum leader role in terms of providing teachers with the opportunities to understand how it's implemented and to try it out.

In regards to teacher collaboration, Kara suggested that the best way to implement formative assessment effectively is in a team teaching situation. Similarly Beth noted, "It is exciting when you have a group of teachers who are all looking at how to improve their instruction." However, Kara claimed that this is not always the case, as suggested by her claim that "I think as teachers it can be a very solitary profession. You are in your classroom with the door closed and it's kind of an uphill battle in terms of getting teachers onboard with these sort of new techniques." Furthermore, she discussed the role leadership plays in encouraging collaboration among teachers, indicating that:

It's really about department and school leadership. So if you have a department head that values collaboration and encourages collaboration and encourages discussions about what good assessment is ... then you end up being a better teacher because you are able to do better work.

From Kara's experiences, when leadership encourages collaboration, teachers are more likely to collaborate and therefore effectively implement formative assessment.

Teacher participants also suggested that student understanding of the purpose of formative assessment is important in order for the strategies to be effective. Kara explained:

Knowing that there's no pressure, that this [formative assessment] is really just for their benefit and I explain the benefit of this is for me to know if you guys

understand it and it is for you to know if you understand it. I think that they recognize that ... this is really only for their benefit, because I am going to test them on it in a week or two.

At the end of the year, Beth compared students' final marks that included formative quizzes and summative assessments with students' final marks that included only summative assessments. This was the first year she found that marks were higher just with summative assessments and she believed it was because students were beginning to understand the purpose of formative assessment. She explained, "I think that maybe kids are getting use to the idea of formative and summative assessment. They are using the language, they understand the purpose." As a result, she claimed that formative assessment strategies were used effectively to improve student understanding.

As has been already noted, the implementation of formative assessment increases a teacher's workload. However, Kara pointed out that by teaching a course one has already taught, it is easier to implement formative assessment ideas, stating that:

Teaching math for so long, I have been teaching the same courses over and over ... my lessons are made, my tests are made. They just have to be modified every time. ... When I am prepping, I have the time to enrich the course, to make sort of these fun activities, these fun [assessment] games. Whereas if I am teaching a brand new course or multiple brand new courses, I don't necessarily have the time to do that.

It appeared all these avenues for success were present, which helped these teacher participants to successfully implement formative assessment strategies in their practice.

Barriers. Teacher participants presented barriers to implementing formative assessment. Both Beth and Kara identified the misconceptions of teachers as a barrier.

Kara stated:

The number one complaint that I hear, and especially they are thinking of applied students, is that if it's not for marks the students won't do it and they won't take it seriously. I think that the people who haven't implemented formative assessment really believe that, but in my experiences that's never been the case.

Similarly, Beth noted that from her experiences, "There was this big fear ... when they first started talking about not counting quizzes, and well the kids won't take them seriously if they aren't for marks." It appeared both participants felt this misconception was something that prevented teachers from completely incorporating formative assessment in their practice. Interesting to note, Beth addressed the barrier that specifically mathematics teachers present. She discussed these as "challenges in the discipline." Beth stated, "I think math teachers don't believe in formative assessment ... in terms of not counting [for marks]. ... I don't know any other teacher who does formative assessments." Beth further explained:

I'm not saying across the province, but I would say that the vast majority of teachers in mathematics do not do any formal attempt at doing formative assessment, peer, self, or teacher led ... because it's not the tradition of math. Math has a long, established tradition and there is this real belief that this is the way it should be done. This is the right way and if we change it, we are going to be diminishing it in some form ... I don't know. I wish it could change because there is so frequently in so many ways this sense that "oh that's good for

everybody else. ... Formative assessment, good for everybody else. I can see how that would be valuable in an English class, but not in math class.” I don’t know, it’s just weird.

Related to this lack of implementation, Beth mentioned that students were not use to formative assessment, which can be an obstacle to its effectiveness. She claimed, “the kids, it’s new for them. They haven’t had formative assessment in math so it takes them a while, some of them, to get it.”

Both teacher participants identified the extra time and work required to implement formative assessment strategies in their classroom as an obstacle. Kara explained, “It can be extra work. If you are collecting 30 quizzes every other day and you are marking them yourselves, that is just extra work and finding the time to do it.” Beth discussed her experiences with teachers who felt formative assessment was too much work. She discussed the importance of “the teacher really believing that it’s worth the time and the effort and the extra marking. ... It’s almost like well if it’s not worth marks, then it’s not worth my time to mark.” Time is a prevalent issue both teacher participants found to be an obstacle.

This theme addresses the various supports and barriers to implementing formative assessment strategies effectively in practice. Teacher participants perceived supports to include strong leadership and teacher collaboration, student understanding of the purpose of formative assessment, and teaching a course previously taught. Participants also outlined barriers to effective implementation including the misconceptions of teachers and the extra time and work load formative assessment can lead to. In order to effectively implement formative assessment strategies, it appears necessary for the teaching

community to put practices into place which promote the supports presented by teacher participants and practices which reduce the barriers presented.

The perceptions of teacher participants highlight various components to the ways in which formative assessment is implemented. Analysis of data suggests that the teacher influences the implementation through personal philosophies, the interpretation of policy documents, and their experiences. The combination of these factors promoted teacher participants' belief in the importance of formative assessment and facilitated the implementation of the strategies in their practice. The ways in which theory is incorporated in practice is highlighted through the examples of implementation participants presented from their classrooms. Moreover, analysis of data suggests teacher participants perceive the formative assessment strategies to be interconnected rather than a set of distinct strategies. Supports and barriers to effective implementation are also presented. These themes provide an understanding of teacher participants' perceptions of the implementation of formative assessment, while the subsequent section will address perceptions of the impact of the strategies.

Ways in which formative assessment strategies impact student self-efficacy and motivation. The teacher participants presented data that led to two themes formed under the topic of the impact on student self-efficacy and motivation. The first theme is formative assessment as an opportunity to “get it.” This theme presents the implementation of formative assessment to be the multiple opportunities provided to students to gain an understanding of learning goals. The second theme is the “diverse cliental of learners,” which addresses the perceptions of teacher participants on the diversity of the impact of formative assessment strategies.

Formative assessment as an opportunity to “get it”. Analysis of interviews with teacher participants suggests that formative assessment provides students with the chance to gain an understanding of the mathematics learning goals. Both teacher participants described formative assessment as the means of providing students with multiple opportunities to gain an understanding of topics before being assessed for marks. Kara believed that “that’s what formative assessments are sort of all about. They do the quiz, they get my feedback, and then they have the chance to rewrite it for marks.” Beth compared learning in a classroom to athletes practicing to compete, stating:

As much as we can, we should be building that into our practice, our assessment practice. Give kids the opportunity to do it again if they did it badly the one time. ... Even lead athletes get more than one opportunity before the Olympics. They get lots of opportunities to practice it in real circumstances and watch the other people and then see the video and get feedback and more training and try to be as good as the person that beat them before they have to go to the big, televised race.

Similarly Kara commented:

I am giving them the opportunities to learn. ... If all you ever did was give a student a test at the end of every unit and then say oh, you don’t know it. Now there is no chance to do better or to improve.

On the topic of formative quizzes completed in class, Kara stated:

The point is that if you do the quiz and you know you did poorly, now you have that opportunity to go back, learn whatever that task was and then when I quiz you on it or I test you on it again, hopefully now you know it ... when it actually counts [for marks].

Important to note, Kara described everything before a test to be formative, as exemplified by her statement, “Everything that we do before a test is formative in some ways. It is just about sort of creating different opportunities and creative opportunities for them.” It appeared that teacher participants perceived formative assessment as the multiple opportunities required to improve student understanding before summative assessments.

Analysis of data suggests that formative assessment also means providing students with multiple opportunities to express their understanding. Beth claimed:

I think that the students do better work. I think they’re given the opportunity to show their best work, which is ultimately what you want for them. You want them to have the opportunity to show you the best work that they can and that’s what it [formative assessment] provides them with.

Beth further added, “Everything that we do should give them a chance to do it again, somewhere at some point, they should have a chance to do it again. I don’t mean re-tests.” Beth explained further how this is the case with formative assessment, stating:

Kids were able to do their best work. They make their mistakes, they get feedback, they fix the mistakes we hope, and when they’re done they’re actually doing the best work that they can instead of just some random snapshot of what they were doing at that moment. They’re actually building to their best work.

The Grade 11 project on modelling functions, which Beth implemented, was structured into sections, because initially she found that strong students were doing well and weaker students were doing poorly. She then realized it was, “Because they don’t have a chance to fix it. They need to have a chance to fix it.” It appeared that by implementing

formative assessment strategies, students are provided with multiple opportunities to demonstrate their understanding and thus they are able to improve.

This theme presents formative assessment as the opportunity for students to “get it.” Teacher participants perceive formative assessment to be a means of providing multiple opportunities for students to gain an understanding of the mathematical concepts and learning goals. Students are provided with multiple opportunities to express their understanding and therefore to improve upon gaps in their understanding.

“Diverse cliental of learners.” Teacher participants described students to be a “diverse cliental of learners” and as a result, formative assessment strategies affect diverse groups of students differently. As Beth sated, “keep it varied and you’re not going to get everybody with everything, but you are going to get everybody at some point I would hope.” As Kara noted, “It depends on the student, their ability, their interest, their learning style.” This theme is organized based on the impact of strategies on student self-efficacy and motivation and the impact on student learning.

Impact on self-efficacy and motivation. Both teacher participants indicated it was difficult for them to ascertain how formative assessment impacts the motivation and self-efficacy of students. Kara stated, “It’s hard. I’m curious to know how they would say it affects them.” Likewise Beth explained, “It’s hard because I can’t get inside a kid’s head.” Despite of this difficulty, both teacher participants were able to discuss some observations. Both participants believed that formative assessment has a positive effect on the motivation and self-efficacy of mathematics students.

Beth discussed that formative assessment can promote learning to be the source of student motivation instead of marks, as indicated by her statement:

The whole reporting, evaluation, marks works so badly for students. It is not a motivator for learning, it's a motivator for achieving for marks which is of course a motivator to achieve more marks ... then kids don't care about their learning. They care about their marks. ... It's like they're going to a mark field and they're picking up marks and putting it in a basket and getting as many as they can into a basket. Formative assessment focuses on learning ... it's all about learning. I wish there was some way to extract kids from that mark-attainment to learning-attainment.

Beth continued to explain how formative assessment is one way to make this move to learning as motivation, stating:

Because they're caring about showing you that they can do it or proving to themselves that they can do it, because they're not accumulating marks from this. Now ultimately they may have a goal that when it is for marks they'll have done better at that point, but they've done the learning. So it's almost like the marks are an aside. It [formative assessment] focuses on the right place; it focuses on the learning, not the mark attainment.

Beth also highlighted that formative assessment is more motivational than evaluation, which she claimed often demotivates students. Beth noted:

That idea that kids are pushed forward through encouragement and our assessment strategies frequently say "no you did this wrong and this wrong." We don't do a lot of that encouragement. ... For a lot of kids it just shuts them down and they may stay shut down for years after that. But formative assessment allows them to fix it. It's not the end, there's an opportunity to get it and fix it.

Similarly Kara claimed, “It [formative assessment] certainly builds up that confidence [in their ability].” Kara also added:

If we can give them the confidence to believe in themselves, then the rest sort of works itself out. You are much more likely to want to do your homework if it is something you think you going to understand or ask questions if you don’t understand, because you think it is something you are capable of understanding. Yeah, so certainly that is definitely the role of the teacher, is getting students to see that they are capable.

It seemed that both teacher participants believed formative assessment to be a means of improving student motivation and self-efficacy.

Teacher participants discussed the impact of providing students with frequent feedback through all the formative assessment strategies. Beth claimed that the recognition feedback provides can positively impact student self-efficacy, as exemplified by her statement:

Everybody likes to be told they are doing better than they were ... recognition also makes you feel good. It doesn’t really matter where the recognition is coming from. It doesn’t have to be coming from the teacher. It could be coming from a peer, it could be coming from yourself ... if you are emotionally sophisticated enough to say you know what, I didn’t know how to do this and now I do.

Similarly, when asked about the benefit of implementing formative assessment, Kara emphasized students’ confidence, stating:

If the students do a formative assessment and they understand things, then they get that confidence, right? They know that they are doing well, so when it comes

to write the test, it's manifest destiny. They know they are going to do well and they do. It's also great that ... if they aren't doing well, I can highlight students who need extra help and, or need to sit down with me and relearn something.

Important to note, Kara addressed that the impact feedback has on students' self-efficacy really depends on the student, as suggested by her claim:

You are giving them more feedback, more often. So more chances to tell them that they are doing a good job. But then I guess in the same token, you are giving them more chances to see that they are not doing a good job if they are constantly failing those formative assessments. So then I guess it really depends on the situation, the student in terms of it would build them up or drag them down.

Beth expressed how feedback received from summative assessment can improve students' confidence in their ability. She claimed that the feedback from summative assessments helped students feel they were capable of improving, while also motivating them to put in the effort to improve. For example, she explained that when given the opportunity to improve assignments based on her feedback, all students wanted this chance. She claimed that this demonstrated that they were motivated to put in the effort to improve. Similarly, she believed that providing feedback on assignments that were divided into sections increased students' motivation and confidence in their ability to do mathematics. Beth provided the example of one Grade 9 student whose mark increased by 30% the second half of the course after one of these projects. She explained what she believed to be the reason for this success, stating:

I attribute it entirely to this project and she was so successful in this project that it changed how she saw herself as a math student in Grade 9 Academic math. ...

This project and the feedback along the way. It changed her attitude.

Although teacher participants highlighted the benefits of providing students with more frequent feedback through formative assessment strategies, they cautioned that the impact depends on the student and the situation.

It appeared that both teacher participants believed that feedback without grades, in particular through the means of providing frequent quizzes, increased student motivation.

Kara found students were asking for quizzes, as indicated by her statement:

I certainly find that they are motivated. Even if I say do you guys want to have a quiz tomorrow? They all say yes because they know it's not for marks, but it is a chance to see how they are doing. They always want them and that I think that is a really strong indicator that it is working.

Similarly, Beth described this as “now you got them” when her students requested formative quizzes, because they believed they could have done better. She claimed:

They wanted a re-quiz of a quiz that didn't count [for marks] in the first place.

Now you got them! Now they are actually caring about proving to themselves that they know how to do it through me saying yes, this is right.

Beth noted a difference in the reasons why feedback without grades on quizzes motivated students based on what course they were in. When discussing senior classes such as Grade 11 and Grade 12 she explained, “They've got enormous time management issues and they felt that with the feedback, they would focus their attention on the things they didn't know.” In regards to college level or applied level students she stated:

I think continuous feedback is what they need. They need to not have long stretches where they're not being told that they are making progress. Sometimes the progress is tiny, but they just need to know that they're doing something right now that they weren't doing before.

Although reasons may vary, both teacher participants found that students were requesting more feedback through quizzes, which the teacher participants believed to improve student motivation.

Both teacher participants claimed that the use of questioning techniques during classroom discussions impacted motivation and self-efficacy. Beth believes classroom discussions increase student motivation because students are able to see that there are “different ways to look at things, there are different tools you can bring in, different connections you can make, and different representations you can use.” She believed this increased motivation as it makes mathematics more engaging, as exemplified by her claim:

They will see somebody do it a different way and they will ask them how they did it. Well if they ask you how you did something, that to me says you're interested in knowing. You aren't getting marks for it, right? You listen to them talk and they are asking each other what they did. That to me speaks motivation.

Kara highlighted that questioning techniques increased student self-efficacy, because the teacher is able to help the student believe that they have the ability to understand. She noted:

I think it shows them that the knowledge that they're gaining is not totally new.

It's something they have the capability to figure out themselves, but they just have

to be prompted and guided and they have to think critically about everything new that they are doing.

Teacher participants highlighted different aspects of classroom discussions; however, both believed these questioning techniques positively impact student motivation and self-efficacy.

Teacher participants believed that self-assessment has an impact on student motivation and self-efficacy. In one classroom activity, Kara provides students with exemplars of work at each level of achievement and students must then assess what level they would give their own work. For example, to achieve a Level 3, “the student must demonstrate the specified knowledge and skills with considerable effectiveness.” (Ontario Ministry of Education, 2010, p. 18). Kara described this activity to be motivational because, “if they understand what the expectations are, then they are much more likely to accomplish them.” Furthermore, she believed this activity can have an impact on student self-efficacy, stating:

If you have those really weak students who see all that great work and they don't feel that they are capable of it, then that is not going to help. But certainly lots of students are at level one and can see okay, I can get to level 2 or I am at level 3 and I can get to level 4. I think that we have that intrinsic motivation ourselves to improve and so knowing what we need to do to get there helps.

In regards to self-assessment activities in general Kara claimed:

If they are not doing well, one thing that is nice is they see right away how to do well. So hopefully they can see okay, I didn't get it this time, but I understand

how to get it next time and so they have the confidence that moving forward they will be able to be successful.

Beth also discussed how self-assessment can motivate students, as exemplified by her statement, “You divulge your time and attention to the stuff you don’t do well because if you’re doing it well already, your chances of moving your mark are small and that is what you care about, your mark.” She claimed that self-assessment can motivate students as they are able to determine what they need to improve on in order to achieve their goal of getting a good mark.

It seems that Beth perceived peer assessment to have an impact on student motivation and self-efficacy and that this strategy played an important role in her classroom. She explained that it is helpful for students to see peers be successful as well as to see that peers have similar struggles. Beth perceived these experiences to promote students’ confidence in their own ability to do mathematics. She also claimed that for reluctant learners regardless of their age, peer assessment is the most powerful formative assessment strategy. She stated:

Working with their peers, looking at projects that their peers have done, “oh can I have an extra day?” You get that kind of stuff. ... Because they are seeing what could happen, what they could have done. They know they could have done it, they just didn’t.

She further addressed the impact as follows:

They take note that other kids are getting marks ... or other kids are learning stuff and getting recognition for having done a good job and that somehow it’s that they’re part of a group and they’re being left behind as the group moves forward

is a much stronger motivator for a reluctant learner than anything I'll ever do or say. ... They are immune to anything I might say, but they're not immune to being left behind by their peer.

Moreover, Beth discussed how students were able to motivate and to encourage each other when participating in peer assessment, stating:

I think kids encourage other kids. Like "oh come on. No don't give up."... They are encouraging, because they care about each other. ... I think all of that helps them. It motivates them, it encourages them. It's much harder to not participate when you are in a group than it is when you are sitting by yourself. When you are sitting by yourself it's easy. You can tune out, you cannot participate, and you can see yourself as lost ... but other people won't let you do that.

Beth considered peer collaboration as peer assessment. She expressed how she felt the use of this strategy increased student motivation, as noted by her statement:

They're all talking like all of the time. There is no risk. It is not like everybody is waiting for them to open their mouth. They're just talking along with everybody else who is talking. And if they make a mistake, well today they make a mistake in what they say, but yesterday it was somebody else so it doesn't matter. Like nobody is without mistakes since they are just talking.

Beth claimed this collaboration increased student motivation, because students are less likely to be afraid to participate and contribute ideas. Important to note, Beth stated that in order for peer assessment to be motivational, a respectful environment among students must be established. If students are discarding a peer's ideas or using language that is not respectful, peer assessment will neither increase students' motivation nor self-efficacy.

Teacher participants also addressed who they believed formative assessment strategies impacted the most. Kara believed formative assessment strategies best influence and provide confidence to students “on the edge” and those who are eager to learn. She explained:

I would say it helps those that are on the edge so those 50-60% students that understand most things, but not necessarily all and the ones that are eager to learn. There is often students who are weak, but still really eager to learn and so it gives them the confidence when they know something and they are assessed on it. And it gives them the awareness when they are assessed on something and they don't know it that they sort of have to catch up and figure it out before we have a test.

Conversely, Beth believes it works for everyone, stating, “if it works for the reluctant learner who is the hardest one to reach and if it works for the really bright kids ... to me its common sense that it's going to work for everybody in between.” Although teacher participants had varying opinions, both participants believed that formative assessment had an impact on the motivation and self-efficacy of their mathematics students.

Impact on student learning. It is important to note that both teacher participants discussed the impact of formative assessment strategies on student learning. Both participants found peer assessment to be an opportunity for students to maintain a leadership role. Beth highlighted the impact of this leadership opportunity for students who she described as “troubled” as follows:

In my Grade 9 Applied that's been really, really good for the kids because these are kids who are troubled ... and to watch those who are in trouble at the office all the time actually get something and then start explaining it to a peer, it is just

wonderful. It's wonderful for the peer, but it's really good for that kid to be that leader and to be a positive influence on someone else's life. How wonderful for 5 minutes ... they're the expert."

Similarly, Kara described the benefit of peer assessment in providing stronger students with the opportunity to take on a leadership role. She claimed, "they get the opportunity to be a teacher and take on that leadership role and to really reaffirm that they understand what they are doing."

Teacher participants emphasized how feedback without grades from the teacher is particularly helpful to improve student understanding for strong students. According to Beth:

The really good student, don't even talk to me what they can do if you just give them feedback and let them continue. You have to give them the chance to continue, but you can get them doing stuff that is way beyond anything that you would expect from a high school student just by giving them a direction to go: "have you thought of? Why don't you look at?" And away they go because they're independent that way, but they need somebody to send them off in a direction, because they don't really know that there is anything else out there. They are at the end of the cliff and they don't know that there is more world if you go around.

Teacher participants noted that although strong students have a lot to gain from working with peers, teacher feedback had the greatest impact in terms of improving understanding. Both teacher participants perceived that formative assessment strategies

improve student understanding; however, the impact depends on the student and the situation like the impact on self-efficacy and motivation.

This theme addresses teacher participants' perception that formative assessment strategies affect diverse groups of students differently. Participants highlighted that formative assessment is a means of transitioning from marks as the source of motivation to learning as the source of motivation. Teacher participants perceive that the feedback provided through all strategies positively impacts student motivation and self-efficacy. Specifically, teacher participants described their perceptions of how feedback without grades increases student motivation as well as how questioning techniques, self-assessment, and peer assessment increase student motivation and self-efficacy. Teacher participants also perceived formative assessment strategies to impact student learning. However, participants perceive that the impact of formative assessment on student motivation, self-efficacy, and understanding depends on the student and the situation.

This section addresses the perceptions of teacher participants in regards to the impact of formative assessment strategies on the motivation and self-efficacy of mathematics students. The perceptions of teacher participants suggest that formative assessment provides the opportunity for students to "get it," that is, to gain a deeper understanding of concepts and learning goals. Moreover, this section highlights that teacher participants perceive that mathematics students represent a "diverse cliental" of learners and as a result, the formative assessment strategies affect different groups of students differently. Nevertheless, overall, the strategies positively impact student motivation, self-efficacy, and understanding.

Chapter Summary

The analysis of data demonstrated the implementation and impact of formative assessment strategies in the secondary mathematics classroom. This chapter first presented results from phase one of the study, which were used to guide the second phase. The results from phase two are then presented with the themes related to the perceptions of student participants discussed first. In regards to the implementation of formative assessment, the themes discussed include the interpretation of formative assessment strategies, the interconnectedness of strategies, and taking formative assessment seriously. In regards to the impact on self-efficacy and motivation, analysis of student participants' interviews led to themes that apply to all strategies as well as themes that are specific to each individual strategy. The themes across all strategies include (a) the sources of student motivation and self-efficacy, (b) the connection between motivation and self-efficacy, (c) peer and teacher judgement, and (d) the perceptions of mistakes. Following discussion of the themes that emerged from the analysis of data from student participants, themes from the perceptions of teacher participants are presented. The themes related to the implementation of formative assessment included the influence of the teacher, theory in practice, interconnectedness of strategies, and support and barriers. Lastly, themes under the topic of the impact on student self-efficacy and motivation are highlighted including formative assessment as an opportunity to “get it” and the “diverse cliental of learners.”

CHAPTER FIVE: DISCUSSION OF RESULTS, IMPLICATIONS, AND CONCLUSIONS

A long-standing societal misconception appears to exist regarding success in mathematics being limited “for the few, not the many” (Ontario Ministry of Education, 2004, p. 9). Policy documents and reports from the Ontario Ministry of Education including *The Report of the Expert Panel on Student Success in Ontario* and *Growing Success: Assessment, Evaluation and Reporting in Ontario Schools* have highlighted the role that assessment practices play in reducing this stereotype. As a result, this study focuses on the implementation of formative assessment strategies within secondary school mathematics classrooms and its impact on student self-efficacy and motivation. This study stemmed from both an analysis of existing literature as well as the consideration of my personal experiences in mathematics classrooms. The perceptions of secondary mathematics students and teachers were explored.

An examination of current literature revealed two important issues. The first issue is that assessment results have a critical impact on student motivation and self-efficacy (Stiggins, 2005, 2010). This is significant because motivation and self-efficacy are important factors for student learning and achievement (Nasiriyani et al., 2011; Zientek & Thompson, 2010). The second issue is that there exists a need to connect research on formative assessment with current classroom practices. Although literature on the benefits of formative assessment is available, the analysis of literature revealed a noteworthy gap in understanding how formative assessment is implemented in the mathematics classroom.

Accordingly, the purpose of this study was twofold. First, this study aimed at exploring the impact of formative assessment strategies on secondary school mathematics student motivation and self-efficacy. Second, the study explored how formative assessment strategies are implemented within the context of a secondary school mathematics classroom. The main research questions that guided the study were:

1. In what ways is formative assessment implemented within the secondary school mathematics classroom?
2. What are the perceptions of the impact of formative assessment strategies on student self-efficacy and motivation in mathematics?

An explanatory sequential mixed methods design was employed to guide this study. Quantitative and qualitative data were collected sequentially in two different phases. The first phase involved quantitative data collection through a student questionnaire on which students responded to questions based on a 5-point Likert scale. Analysis of data provided a general understanding of students' perceptions of mathematics and of the impact of formative assessment strategies on their self-efficacy and motivation. The second phase consisted of qualitative data collection through individual interviews with student and teacher participants. Interview questions were developed based on analysis of data gained from phase one.

Analysis of the data found that formative assessment is implemented in practice in diverse ways. Some interpretations of strategies are consistent with existing literature while others differ. Formative assessment appears to be a process where the strategies are interconnected. Findings indicate that teachers in this study had difficulty in applying peer and self-assessment. Key factors described as influencing the implementation of

formative assessment strategies include teaching philosophies, interpretation of ministry documents, teachers' experiences, leadership in administration and department, teacher collaboration, misconceptions of teachers, and student understanding of formative assessment. The results suggest that, overall, formative assessment strategies positively impact student motivation and self-efficacy; however, individual students are impacted differently. Some considerations include how students perceive mistakes and whether they fear judgement. Self-efficacy and motivation are positively impacted because formative assessment strategies provide feedback that offers students encouragement and recognition by highlighting the progress that has been made and what steps need to be taken to improve further. Moreover, the impact of formative assessment is influenced by the connection between self-efficacy and motivation, namely, how well a student is doing is a source of both concepts.

This chapter will focus on a discussion of the results of this study, which is guided by the research questions and theoretical framework. The results from teacher and student participants are discussed concurrently. The implications of this research in terms of practice and theory are then presented. This chapter concludes with a consideration of possible areas for further research based on the findings of this study.

Discussion of Results

This section presents a discussion of the study's findings. A diagram illustrating the relationships among findings was developed using the research questions from the study and themes that emerged based on data analyses (see Figure 2). This diagram will frame the discussion of the results.

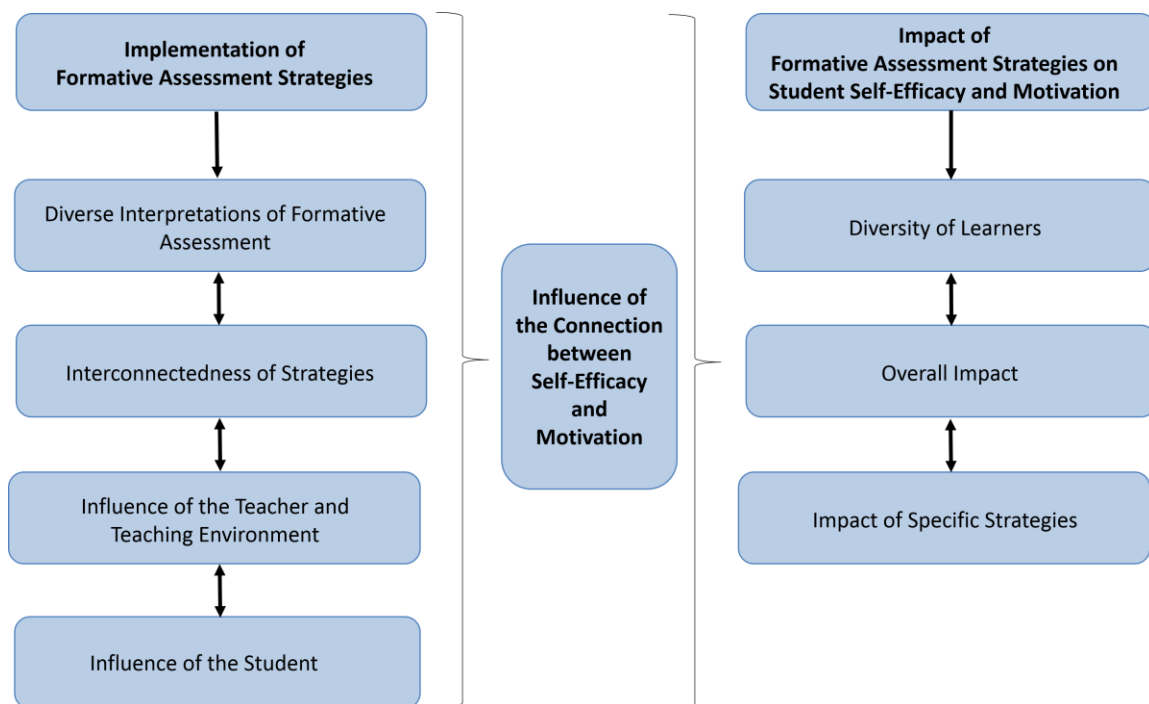


Figure 2. Descriptive diagram of the relationships among findings.

Implementation of Formative Assessment Strategies

Discussion in this section focuses on the implementation of formative assessment strategies in the secondary school mathematics classroom. This section highlights how research translates into practice and the connections to existing literature. Specifically, the diverse interpretations of formative assessment, the interconnectedness of strategies, the influence of the teacher and teaching environment, and the influence of the student are examined.

Diverse interpretations of formative assessment. In regards to the implementation of formative assessment strategies, findings indicate that some of the teachers' and students' interpretations of the strategies are consistent with literature while others appear to differ. Specifically with respect to the strategy of questioning techniques, the interpretations of teachers and students centered on classroom discussions. Students referred to their teacher's use of prompting to develop student understanding during classroom discussions as an example of questioning techniques. Students highlighted their teacher's encouragement to participate in classroom discussions with the goal of exploring student thinking and determining whether students understood the topics. Similarly, teachers in this study perceived the purpose of questioning techniques as eliciting student understanding and to discover students' misconceptions. Teachers highlighted strategies such as the use of exit cards, examining common errors made on assessments, and their experiences previously teaching the subject to modify class discussions in order to address the gaps in student learning. These findings are consistent with existing literature, which discusses framing questions in order to explore student understanding, gaps in student learning, and misconceptions that students may have. As a

result, teachers are provided with the information required to differentiate learning by modifying instruction and resources (Black et al., 2004; Earl & Katz, 2006).

Students in the study stressed that their teachers were interested in their thinking regardless of the accuracy of their response. Both teacher and student participants referred to engaging classroom discussions where there was more than one correct answer to questions. These discussions were not aimed at getting a specific answer, but rather to develop student understanding of the topic. These findings are in line with the literature from Black et al. (2004), which emphasize that questioning techniques should improve student understanding and explore important issues central to learning goals rather than target a specific answer. Teacher participants also claimed that in order for questioning techniques to be successful, it is necessary that students are actively engaged in discussions. It appears that a culture of respect and encouragement must be established in order for students to be willing to participate in class discussions and, thus, the formative assessment strategy of questioning techniques to be implemented successfully. The interpretations of questioning techniques by teachers and students in this study are applicable across other subjects or contexts, such as elementary classrooms; however, the necessary culture of respect and encouragement seems to be particularly important at the secondary school level. As findings in this study suggest, students fear judgement from peers, an issue that seems to become increasingly prevalent at the secondary school level. The importance of fostering a culture of respect and encouragement is not only essential for the formative assessment strategy of questioning techniques, but across all strategies and, in particular, for peer assessment.

Consistent with existing literature, teacher perceptions address the use of feedback without grades to provide students with an awareness of gaps in their learning to facilitate improvement (Black et al., 2004; Crooks, 1988; Earl & Katz, 2006). Consistent with Earl and Katz (2006), teacher participants discussed feedback without grades to be a means of making connections between the students' current level of understanding and their learning goals. Both teacher participants in this study claimed that feedback without grades must be specific and provide students with direction on how to improve their learning. In keeping with Black et al. (2004), teacher and student participants explained that feedback provides students with what they have done well, what improvements need to be made, and what steps need to be taken to improve. Some teachers and students interpreted the use of formative quizzes to be part of the strategy of feedback without grades. Consistent with what Black et al. discuss, students understand that these assessments are part of the learning process rather than a summative judgement and are implemented for the purpose of improving understanding. One teacher participant added the interpretation of providing written feedback without grades on homework collected from younger students.

Both teacher and student participants also discussed providing students with verbal feedback during classroom discussion as a means of providing immediate and detailed feedback to guide learning. Notably, one teacher from this study highlighted the use of classroom games to provide immediate feedback to students. For example, in a whiteboard game, students solve a mathematics problem and hold up the answer on an individual whiteboard when finished. This teacher presented games as part of the consolidation piece of a lesson, which is in reference to the three-part mathematics lesson

plan emphasized in Ontario. The consolidation piece is the final part, which has the goal of consolidating learning and providing opportunities for students to reflect on their learning (Literacy and Numeracy Secretariat, 2011). This interpretation of the strategy of feedback without grades is therefore particularly relevant for the mathematics classroom in Ontario.

In regards to the interpretation of self-assessment, several examples were provided by both teachers and students that supplement the existing literature. Findings suggest that teachers and students in this study classify homework to be a form of self-assessment. One teacher provided the example of having students rate their understanding of their homework on a Likert scale to promote metacognitive processes. Although homework may not be traditionally considered self-assessment, upon revisiting the existing literature, this interpretation is applicable. Homework enhances the development of the metacognitive processes of students monitoring their own learning and using their judgement to modify their thinking to improve understanding (Earl & Katz, 2006).

Students also perceived self-assessment as reviewing teacher feedback on marked tests or assignments. One student participant identified a journal that the class used to document functions throughout the course to be a form self-assessment. Kara considered having students mark their own quizzes to be self-assessment, because students are involved in the assessment process and they become better aware of the learning goals. In addition, she interpreted the use of challenging thinking or application questions to be an opportunity for self-assessment. After solving a question, the students and teacher collaborate to discuss the criteria for a strong answer. Then, based on the criteria, the students reflect on their own work, determine what needs to be done to improve, and then

make the necessary improvements. This interpretation appears to be consistent with literature because student metacognitive processes, such as monitoring their own learning and using their judgement to modify their thinking, are promoted (Earl & Katz, 2006). This interpretation of self-assessment can be applied to other subjects because within the Ontario context, the four categories of knowledge and skills are common to all subject areas, which includes the categories of thinking and application (Ontario Ministry of Education, 2010). The other teacher in this study, Beth, identified an interpretation of self-assessment as providing students with a choice regarding which questions they chose to answer on formative quizzes or summative assessments. Similar to the findings of Volante and Beckett (2011), findings from this study provide interpretations of self-assessment that are both teacher- and student-directed activities. However, it is noteworthy that findings indicate that students perceive that self-assessment works best on a voluntary basis completed at home. This result may be specific to secondary school students who have had the opportunity over time to develop the skills necessary for self-assessment and the maturity to do so on their own. It is interesting to note that Beth perceived that “formal self-assessment activities,” such as the portfolio, do not encourage authentic reflections and, therefore, she did not incorporate them into her practice. This finding is consistent with research that indicates that teachers struggle with effective implementation of self-assessment (Volante & Beckett, 2011).

Volante and Beckett (2011) also highlight that teachers struggle with the implementation of peer assessment. Findings from this study are consistent as both teacher participants discussed the difficulty with peer assessment, in particular, with the traditional examples where students trade their work with peers to be assessed. Teachers

noted issues with students feeling embarrassed about their work or fearing peer judgement. The students in this study present similar perceptions as they address their fear of peer judgement. This finding adds to the existing literature from Volante and Beckett who present the factors of friendships, lack of content knowledge, and interest when discussing issues surrounding peer assessment. It is interesting to note that teachers in this study perceived there to be a lack of implementation of peer assessment in mathematics classrooms and a lack of exemplars for teachers to follow. However, teachers did find some ways of implementing this strategy in their classrooms that are noteworthy to discuss.

Teachers and students in this study found the implementation of gallery walks with either work completed in groups or individually to be effective peer assessment. Students are able to provide peers with feedback using their own language and are able to discuss the criteria of a good solution. It appears this process helps them to understand learning goals and improve their own work. Further examples of peer assessment identified by teachers and students in this study include: Kara's snowball activity, graphic organizers where peers are able to provide feedback on each other's work, reviewing formative quizzes in groups where students are required to ensure all students have fully correct solutions, and activities where students work together on a question with multiple possible solutions. These examples of peer assessment are activities where students are assessing the work of peers with the goal of improving understanding through the feedback provided. These interpretations stress how peer assessment is not meant to be an evaluation of peers' work, but instead assessment for the purpose of improving learning (Assessment Reform Group, 2002; Black et al., 2004; Earl & Katz, 2006; Stiggins &

Chappuis, 2005). Both teachers in this study referred to peer teaching and collaboration on work as an implementation of peer assessment. This interpretation contributes to the existing literature. Beth referenced peer teaching and collaboration as an “organic” form of peer assessment. Students are able to receive feedback about their work in the language of their peers, which is consistent with the literature from Black et al. (2004) on peer assessment.

Black et al. (2004) indicate that summative assessment should be an integral part of the learning process. They argue that when students review their completed summative assessments and implement self-assessment strategies to assess their learning and address deficiencies, learning is improved. Consistent with this argument, one teacher from this study provided students with the opportunity to improve summative assignments based on her feedback. In addition, Beth structured a summative project to be completed in sections so that students were able to improve their work based on her feedback. Students discussed the opportunity to review their teacher’s feedback on summative unit tests. Students were able to use this feedback to help them address their mistakes in order to improve on subsequent assessments.

Furthermore, Black et al. indicate that an upcoming summative test can provide the opportunity for students to reflect on what has been learned so that they can prepare adequately for a test. Consistent with this idea, Kara and her students identified practice tests prior to a summative test as an interpretation of the formative use of summative assessments. A practice test is an opportunity for students to review their work and to determine what needs to be done to improve before their test. It is important to highlight that some students referred to formative quizzes, which are implemented for the purpose

of providing students with feedback and are typically categorized as an implementation of the strategy feedback without grades, as the formative use of summative assessments. It appears students had this interpretation because quizzes had been implemented solely for summative assessment purposes in the past. This study contributes to the existing literature within the Ontario context. The teachers in Volante and Beckett's (2011) study interpreted the formative use of summative assessment to involve analyzing provincial assessment results. In contrast, participants in this study provide additional interpretations outside of the provincial assessments of this formative assessment strategy. This is an important contribution to the literature, because within the mathematics classroom, provincial assessments occur at the end of the semester. Instead, the interpretations provided by teachers and students in this study occur throughout the term and are therefore incorporated throughout the learning process. These interpretations of the formative use of summative assessments works towards Black et al.'s goal of making summative assessment an integral part of the learning process.

The students and teachers in this study provide numerous interpretations of the formative assessment strategies. These interpretations, specifically within the Ontario mathematics classroom, both support and contribute to existing literature on formative assessment. Although teachers and students were able to highlight issues surrounding the implementation of some strategies, namely self-assessment and peer assessment, the diverse interpretations provide exemplars of how research translates into practice.

Interconnectedness of strategies. One of the pivotal findings from this study is that the implementation of formative assessment appears to be a process where rather than being distinct processes, the strategies are interconnected with one another. Students

and teachers in this study discussed the connection between the formative use of summative assessments, feedback without grades, and self-assessment. Students explained the process of self-assessment that occurs after receiving their marked summative assessment. Students assessed their work based on their teacher's feedback and their own interpretation of what needs to be done to improve and then took the necessary next steps. As indicated in the literature, the formative use of summative assessments improves student learning when students review their summative assessments, assess their learning, and address gaps in their understanding through the implementation of self-assessment strategies (Black et al., 2004). Moreover, Earl and Katz (2006) describe feedback as the link between the assessment of a student's understanding and the actions that occur to improve learning. Kara's use of practice tests after they have been marked represents another example of the interconnectedness of these strategies. Students are able to determine what needs to be done to improve and then take the necessary steps to address the gaps in their learning before the summative test. Similarly, results indicate that on an even broader level, teachers in this study found a connection between feedback without grades and self-assessment on all assessments, both formative and summative. As Crooks (1988) stated, feedback helps students to become aware of misconceptions and consequently improve gaps in their learning. One of the teachers in this study highlighted that although feedback is intended to initiate a self-assessment process, it is the responsibility of the student to take the necessary steps to improve. It appears that this perception is applicable specifically to the context of secondary school because, as Black et al. (2004) note, teachers must first help students develop the skill of self-assessment.

Teachers in this study perceived there to be a connection between the strategies of feedback without grades and questioning techniques during classroom discussions. Black et al. (2004) state that questioning techniques inform teachers about students' prior knowledge, misconceptions they may have, and gaps in learning. It appears that teachers in this study perceived these strategies to be connected, because they can provide specific and detailed verbal feedback with the goal of improving student learning based on the understanding of the students' level of comprehension gained from questioning.

One teacher in this study discussed the connection between questioning techniques and self-assessment. Through questioning techniques, she presented mathematics problems and discussed with students what criteria would be required to provide a complete, correct solution. She subsequently had students assess their own work and address any deficiencies in their understanding. Black et al. (2004) note that in order to achieve a learning goal, it is necessary for students to understand the goal and be able to determine what is required to achieve it. Self-assessment provides the opportunity for students to develop this skill. These discussions and questioning techniques enabled students in this study to better understand learning goals, determine gaps in their own understanding, and establish how they can improve. Similarly, student participants highlighted the connection between teacher questioning techniques and peer assessment. Findings indicate that teacher questioning techniques led to peer assessment as students are able to provide feedback to peers based on each other's responses.

Findings from students in this study point to the connection between self-assessment and peer assessment. The students noted that, based on peer assessment activities, they were able to assess their own understanding and determine what steps

need to be taken to improve. This included both activities where they were providing peers with feedback and when they were receiving feedback.

As explained in Chapter 2, when defining formative assessment, both Black and Wiliam (2004) and Andrade and Cizek (2010) place emphasis on the purpose of the assessment rather than the task or tools being used. Findings from this study seem to support this point as the formative assessment strategies of questioning techniques, feedback without grades, self-assessment, peer assessment, and the formative use of summative assessment appear to be interconnected rather than a set of distinct strategies. Consequently, findings appear to indicate that in the secondary mathematics classroom when discussing formative assessment, it is accurate to place emphasis on the purpose of the assessment rather than the specific tasks and strategies implemented. This study further contributes to the existing literature by presenting the formative assessment strategies as an interconnected process.

Influence of the teacher and teaching environment. In regards to the influence of the teacher on the implementation of formative assessment strategies, there are findings that were noteworthy and merit further discussion. These include the influence of teachers' personal philosophies, experiences, interpretation of the Ministry of Education documents, and teaching environments.

Teachers' personal philosophies appeared to influence the implementation of formative assessment strategies. Both teachers in this study had a strong teaching pedagogy that included the belief in the importance of formative assessment in the mathematics classroom. For example, Beth strongly believed that as an educator her primary role is to teach, not to evaluate. Therefore, she perceived that the implementation

of formative assessment is essential, because it is the teacher offering guidance with the goal of helping students improve. In addition, each participant seemed to have a strong sense of self as a teacher, which fostered their ability to advocate for the implementation of formative assessment strategies, regardless of the assessment practices of co-workers. As Kara explained, she felt confident enough in herself as a teacher that, in addition to advocating for its implementation for her own students, she felt she could share it with other teachers. Teaching philosophies also seem to have an impact on which strategies teachers place emphasis within their classrooms and how the strategies are implemented. For example, Beth placed emphasis on peer collaboration and therefore implemented numerous peer assessment activities. The findings of this study support existing literature that suggests that teacher perceptions of teaching and learning influence how they teach and what students learn and achieve (Brown, 2004). This study contributes to the literature by addressing how teachers' philosophies of education impact their formative assessment practices.

Teachers' personal experiences also seem to influence their implementation of formative assessment strategies. Kara started her career in a school environment that promoted strong and progressive assessment values, which contributed to her perception of the importance of formative assessment strategies. Beth's experiences of being a parent and viewing the benefits of formative assessment in her children's classes outside of mathematics prompted her to begin implementing formative assessment, primarily feedback without grades. These experiences supported the teachers' understanding of the benefit of formative assessment and therefore promoted its implementation in their classrooms. This finding offers a different perspective than Brown (2004) who found that

teachers' demographics and school demographics do not influence teachers' perceptions of assessment. In contrast, this study points to an influence of teachers' experiences, both within and outside the classroom, which appear to foster the implementation of formative assessment strategies in practice.

It is also important to note that teacher participants referred to their interpretation of the Ontario Ministry of Education's policy and curriculum documents, which promoted the implementation of formative assessment in their teaching practice. Teachers predominantly discussed *Growing Success* and the policy document's emphasis on formative assessment, which is to be employed to improve student learning and is not meant to be an evaluation. This is consistent with the literature, because the policy document emphasizes that the primary purpose of assessment is to improve student learning (Ontario Ministry of Education, 2010). One teacher participant also pointed out the emphasis on self-regulation within the curriculum documents, represented by the mathematical process expectations, and which is reflected within the learning skills in *Growing Success*. Teachers' interpretations of and the value they placed on the Ontario Ministry of Education's policy and curriculum documents promoted their implementation of formative assessment within their classrooms. This finding offers an example within the Ontario context, which supports literature that suggests the success of assessment policies may rely on the perceptions and meanings that teachers give to those policies (Brown, 2004). This finding also suggests that for the teachers in this study, the assessment and evaluation policy framework *Growing Success* was successful in its aim to increase assessment literacy across the province (Volante & Beckett, 2011).

This study brings to light the fact that there are circumstances within the teaching environment that support the implementation of formative assessment. One factor is the importance of strong leadership with respect to administration and within the mathematics department. Strong leadership can ensure teachers are provided with the opportunities to understand how to effectively implement formative assessment and the benefits of this practice. Findings indicate that strong leadership can also promote teacher collaboration, which is helpful in the implementation of formative assessment. As one teacher in this study claimed, formative assessment is best put into practice in a team teaching situation. This study adds to the literature from Volante and Beckett (2011) that suggests that teachers prefer self-directed professional development approaches such as Professional Learning Communities (PLCs) in order to achieve more sustained changes in their classroom practice. Taking these findings into consideration, leaders within schools should encourage teacher collaboration and provide opportunities to learn about effective assessment practices through initiatives such as PLCs. Teacher participants also highlighted that teaching a course multiple times facilitates the implementation of formative assessment strategies. The workload is slightly decreased when the course has previously been taught, and teachers therefore have more time to invest in the implementation of formative assessment.

It should be highlighted that the results of the study pointed to factors within the teaching environment that appear to hinder the implementation of formative assessment. Both teacher participants claimed that the misconceptions of teachers are a barrier to implementation. In particular, teachers perceived that some of their colleagues believed that students would not take formative assessment strategies seriously if they were not for

marks. Based on their experiences, both teachers in this study did not find this to be an issue. Another prevalent barrier is the extra time and work required to implement formative assessment. As Beth highlighted, it is necessary for the teacher to believe that it is worth the time and effort to implement formative assessment strategies for students and teachers alike. These findings bring into consideration the importance of professional development to address the pragmatic challenges of implementing formative assessment such as teacher workload and challenges around providing feedback versus evaluation at the secondary level.

The results of this study emphasize the influence of the teacher and teaching environment on the effective implementation of formative assessment strategies within the classroom. Teachers' personal philosophies, personal experiences, interpretation of the Ministry of Education documents, and teaching environment seem to play a role in promoting the implementation of formative assessment strategies.

Influence of the student. As indicated by findings from this study, students seem to have an influence on the implementation of formative assessment strategies. Teachers in the study claimed that in order for implementation to be effective, it is essential for students to have an understanding that the purpose of formative assessment is to improve student learning. It seems that when students have an understanding of its purpose and benefits, they are more likely to take formative assessment seriously. Similarly, students negatively influence the implementation of formative assessment when they do not take the assessments seriously. Some student participants indicated that when assessments were not for marks, they tended not to focus on them. This perception is consistent with the results of Peterson and Irving (2008) who found that some students perceived

assessment and feedback to be “irrelevant” when they are not given a mark (p. 247).

Some students also mentioned a lack of motivation to prepare for formative assessments.

It is important to note that student responses focused on the use of feedback without grades on formative quizzes. One student indicated that these formative quizzes were not serious enough and what really counted was summative assessments. Interestingly, it is important to note that all students who had this perspective were in Grade 12. This could potentially be the case because of the importance placed on marks by senior students attempting to get into postsecondary education. This finding is consistent with literature, which highlights that particularly at the secondary school level, teachers experience challenges with providing feedback without grades (Volante & Beckett, 2011).

Moreover, in the past, quizzes were graded and part of report card marks. However, as Black et al. (2004) explain, focusing on feedback instead of grades is necessary to improve learning because assessment should be considered to be a step in the learning process rather than just a summative judgement. It is therefore important for teachers to take into consideration the influence of students if they wish to effectively implement strategies within the classroom. Teachers must help students to develop an understanding of the purpose and benefit of formative assessment in order for students to positively influence its implementation.

Impact of Formative Assessment on Student Self-Efficacy and Motivation

The impact of formative assessment strategies on the motivation and self-efficacy of secondary school mathematics students will be addressed in this section. The discussion considers the diversity of learners, the overall impact, and the impact of specific strategies.

Diversity of learners. Teachers in this study described students as a “diverse clientele of learners.” The perceptions of teachers and students indicate that formative assessment strategies affect various groups of students differently. In particular, it seems that how students perceive mistakes and judgement from peers or teachers has an influence on the impact of formative assessment strategies. These findings merit further discussion.

Results indicate that how students perceive mistakes influences the impact of formative assessment strategies on student self-efficacy and motivation. Some students perceive mistakes to be an opportunity to receive constructive feedback and therefore making a mistake is a learning experience. When discussing the formative use of summative assessments, these students perceived the mistakes made on summative assessments to be opportunities to improve their understanding for subsequent assessments and exams. Some students considered the strategy of feedback without grades to be a learning opportunity when their teachers focused feedback on what their mistakes are and what they need to do to improve before summative assessments. It appears that students who perceive mistakes positively are more receptive of formative assessment strategies. Consequently, the learning opportunities provided by formative assessment strategies are more likely to positively impact the self-efficacy of these students. In contrast, other students in the study perceived mistakes negatively and they did not always perceive formative assessment strategies as opportunities to improve their understanding. It seemed that these students’ perceptions were that mistakes are something negative to ignore. Regardless, if it was the strategy of feedback without grades where teachers provided feedback on formative assessments or if it was the

formative use of summative assessments, students did not want to review their mistakes or be reminded of an assessment on which they did poorly. These students' perceptions seem to indicate that for them, formative assessments may negatively influence their self-efficacy because mistakes are considered to be adverse.

As Bandura (1977) indicated, one of the major sources of a person's self-efficacy is performance accomplishments. In order to develop a resilient self-efficacy, learners must be able to deal with failure by using the experience of overcoming obstacles through perseverance as a learning opportunity rather than being demoralized (Bandura, 2012). Although the purpose of summative assessments is accountability, ranking, or identifying competence, the primary purpose of formative assessment is the promotion of student learning (Black & Wiliam, 2004; Black et al., 2004). If students are unable to view mistakes as learning opportunities, the collaborative process of formative assessment between the teacher and students may be lost (Andrade & Cizek, 2010). Moreover, it appears that self-efficacy may be negatively impacted as students become demoralized when faced with obstacles. In contrast, students who perceive mistakes as a learning opportunity are able to attempt to improve upon the gaps in their understanding that formative assessments identify. These students can experience overcoming obstacles through perseverance and consequently develop a resilient self-efficacy.

In regards to motivation, students who perceive mistakes negatively reflect a performance goal orientation, which is associated with avoiding appearing incompetent (Elliott & Dweck, 1988; Pajares, 2006). From this goal orientation, mistakes elicit anxiety (Ames & Archer, 1988). Formative assessment aims to improve student understanding and achievement by identifying strengths along with weaknesses and areas

for improvement (Andrade & Cizek, 2010). The performance goal orientation undermines the impact of formative assessment. Rather than improving student understanding and achievement, formative assessment may decrease student motivation if mistakes elicit anxiety and, consequently, students focus on avoiding appearing incompetent. In contrast, students who consider mistakes as part of the learning process reflect a mastery goal orientation (Ames & Archer, 1988). This goal orientation is associated with positive academic self-efficacy (Pajares, 2006; Roeser et al., 1996) and persisting longer when faced with difficulty (Ames & Archer, 1988; Elliott & Dweck, 1988; Pajares 2006). In order to foster a mastery goal orientation among students, teachers must promote the perspective that mistakes are part of the learning process (Ames, 1992; Cauley & McMillan, 2010).

Results of this study indicate that students' fear of judgement from peers and teachers seem to influence the impact of formative assessment strategies on student self-efficacy and motivation. Consequently, various students are impacted differently by assessment strategies. The perceptions of some students reflected a hesitance to participate when teachers are implementing questioning techniques due to a fear of being judged by peers. Although students had a positive relationship with their teachers, some demonstrated a fear of appearing incapable to their teachers and feared their judgement. As a result, students expressed a lack of willingness to participate in classroom discussions. This fear of judgement is also evident during peer assessment activities. Students' perceptions pointed to this fear existing both when they are required to provide peers with feedback and when they receive feedback.

In the literature, another source of self-efficacy is emotional arousal, which involves the stress and anxiety elicited in a given task (Bandura, 1977). Self-efficacy can be improved by reducing emotional arousals such as fear and stress. The way individuals interpret their emotional state impacts how they perceive their self-efficacy (Bandura, 1977, 2012). As Stiggins (2005) explained, there are critical emotions underlying how students decide whether they are capable of succeeding and whether the learning is worth the required effort. Some of these feelings include anxiety, fear of failure, and uncertainty, which stem from students' self-efficacy as reflected in assessment results. It seems that when students participate in formative assessment activities where they feel stressed and fear judgement, this may increase their feelings of uncertainty and, thus, their self-efficacy is negatively impacted. Moreover, as outlined in Chapter 2, another source of self-efficacy is verbal persuasion, which involves the messages conveyed by others (Bandura, 2012). If students feel that the messages being conveyed by peers or teachers are negative and in the form of a judgement, this may negatively impact their perceived self-efficacy. With respect to motivation, the performance goal orientation is associated with seeking positive judgements of ability and avoiding appearing incompetent (Elliott & Dweck, 1988; Pajares, 2006). If students fear judgement and, as a result, are hesitant to participate in formative assessment strategies, this could be as a result of a performance goal orientation to motivation. It is important to note that if students are not willing to participate in the formative assessment activities, they are unable to benefit from the potential positive impacts that the strategies can have on improving their learning, motivation, and self-efficacy.

Because the findings suggest that the impact of formative assessment strategies

varies according to different students, it is vital that the teacher uses an extensive range of strategies and activities. As one teacher in this study emphasized, although the teacher may not reach every student every time, the teacher will be able to reach all students at one point. The following subsections will further discuss the impact of the formative assessment strategies on students' self-efficacy and motivation.

Overall impact. Teachers in this study provided perceptions on the general impact of the implementation of formative assessment on students' motivation and self-efficacy. Discussion in this section will focus on the overall impact of formative assessment, while the subsequent section will address the impact of each specific strategy.

Teachers' perceptions indicated that, overall, formative assessment positively impacts student motivation and self-efficacy. One teacher's perception indicated that formative assessment increases student self-efficacy, because the strategies provide the opportunity for teachers to help students to feel that they are capable of being successful at mathematics and to build their confidence in their ability. Teachers' perceptions suggested that providing students with frequent feedback through all the formative assessment strategies can positively influence students' self-efficacy. The recognition that feedback provides, whether from the teacher, peers, or even oneself through self-assessment, encourages students by highlighting the progress that has been made. This is consistent with the literature, which indicates that beliefs about one's self-efficacy can be influenced by the messages conveyed by others (Bandura, 2012). This source of self-efficacy is identified as verbal persuasion in social cognitive theory (Bandura, 1977). The feedback, encouragement, and recognition that teachers' perceptions identify can be

considered verbal persuasion that can positively impact students' self-efficacy. Furthermore, teacher perceptions indicated that if formative assessment identifies gaps in learning, students are given the direction so that they know how to improve before another assessment, whether formative or summative. This can also positively impact student self-efficacy based on the source of performance accomplishments. This is an influential source of self-efficacy as it is based on personal mastery experiences (Bandura, 1977). Self-efficacy can be positively impacted as students experience overcoming obstacles in their learning process through perseverance. Furthermore, this supports Stiggins's (2010) call for assessments to build students' self-efficacy by helping them understand what success is and how assessment results can be used to attain learning goals.

In regards to motivation, unlike evaluation, which one teacher describes to be "demotivating," formative assessment increases motivation through encouragement and by providing students with opportunities to improve upon gaps in their learning. In addition, teachers' perceptions indicated that formative assessment may help make learning a source of student motivation rather than marks. As one teacher explained, reporting, evaluating, and marks focus on achieving marks. In contrast, formative assessment focuses on learning rather than mark attainment. Teachers' perceptions suggest that formative assessment may help to move learners' motivation from a performance goal orientation to a mastery goal orientation based on the achievement goal theory (Meece et al., 2006). A performance goal orientation focuses on meeting normative performance standards, while, in contrast, a mastery goal orientation places emphasis on learning, understanding, and improving (Cauley & McMillan, 2010; Meece

et al., 2006). As explained in Chapter 1, a mastery goal orientation has been related to positive academic self-efficacy (Roeser et al., 1996). The teachers' perceptions are further supported by Black et al. (2004) who stated that when feedback demonstrates to students what they can do to improve, the importance of effort is emphasized and a mastery goal orientation is promoted. In contrast, feedback in the form of marks encourages performance goal orientation and the self-efficacy and motivation of low achievers is negatively influenced (Black et al., 2004). It is important to note, that as teachers' perceptions suggested, the impact of formative assessment strategies on students' self-efficacy and motivation depends on the student and situation.

Impact of specific strategies. The remainder of the discussion on the impact of the formative assessment strategies on students' motivation and self-efficacy is categorized based on each of the strategies. It was the teachers' perception that it is difficult to determine the specific impact of formative assessment on students' motivation and self-efficacy. As a result, most of the discussion surrounds on the perceptions of students.

Questioning techniques. Several students perceived the use of questioning techniques to be motivational. When teachers encourage students to express their thinking in classroom discussions, students voiced an increased motivation to participate and to continue investing effort. It was the perception of most students that their motivation is increased when teachers' questions explore student thinking and are not just concerned with the correct answer. For example, classroom discussions made one student in this study more motivated to come to class as she felt they were very important and something that she could not miss. It seems that the use of questioning techniques

promotes a mastery goal orientation, because the process of learning is valued and effort is perceived as important for success (Ames & Archer, 1988). When questioning techniques are implemented with the purpose of exploring student thinking, the development of a mastery goal orientation is fostered because teachers are focusing on skill development and mastery (Meece et al., 2006). Questions are not targeted at a specific, correct answer, but rather to develop and improve understanding (Black et al., 2004). Moreover, one teacher described the use of questioning techniques to motivate students as they were able to understand that mathematical concepts can be approached in multiple ways and that there are different ways to investigate concepts or problems. She perceived that this understanding increased student motivation as it makes mathematics more interesting. Notably, it was the perception of another student that the use of questioning techniques resulted in an increase in motivation, which was gained from peers' successes. Although a performance goal orientation represents a focus on striving to be better than others (Meece et al., 2006), this finding did not seem to represent this goal orientation. Instead, the student seemed to gain motivation, because she too wanted to experience success and "catch up" to peers.

In contrast, a few students stated that they did not have motivation to participate in class discussions when their teacher is implementing questioning techniques. Some students perceived a decrease in motivation when their teacher is implementing questioning techniques and they do not know the answer. It was the perception of some students that questioning techniques could negatively impact student motivation if they were consistently wrong and if their teacher did not subsequently provide prompting to help improve their understanding. It is possible that this reflects a performance goal

orientation, which is associated with avoiding appearing incompetent (Elliott & Dweck, 1988; Pajares, 2006). Some students expressed negative and neutral perceptions towards questioning techniques that were not focused on the correct answer, but instead implemented to explore student understanding. These students wanted to know the right answer and were not interested in spending time on incorrect ideas.

Findings indicate that students perceive questioning techniques to increase students' self-efficacy as the teacher is able to help students focus on the important aspects of a topic. Students in this study described an increase in confidence in their ability as their teacher was able to prompt them and provide feedback so that they were able to answer similar questions. Similarly, teachers' perceptions indicated that they believe questioning techniques increased students' self-efficacy because through prompting and guidance, teachers are able to help students recognize that they have the capacity to understand a concept. Students' perceptions seem to point to an increase in confidence because they were able to share their thinking, which as one student described, made him feel like a leader. These impacts can be attributed the self-efficacy source of verbal persuasion (Bandura, 1977). The messages conveyed by others can influence beliefs about one's self-efficacy (Bandura, 2012). When teachers are able to prompt students through questioning techniques, students are able to understand that they have the capacity to understand the mathematical concepts, which therefore improves their perceived self-efficacy. Moreover, teachers are able to validate students' understanding of concepts or skills, which can increase students' self-efficacy. Students' understanding is further validated when they are able to express their understanding to peers.

Students' perceptions also seem to indicate that students' self-efficacy is increased because of the way teachers ask questions. Multiple students are able to provide input and they feel they are able to work through problems together with peers and combine ideas to achieve the complete understanding of a topic. One student also expressed an increase in self-efficacy as she felt reassured that other students make mistakes as well. This increase in self-efficacy can be attributed to the source of self-efficacy that is vicarious experience, which involves observing others similar to oneself perform tasks and taking note of the resulting consequences (Bandura, 1977).

In contrast, some students' perceptions in this study indicated that questioning techniques might decrease confidence in their ability. These students addressed feelings of a loss in control when their teacher was asking questions and a decrease in confidence in their ability when other students understand and are able to answer questions and they are not. Based on the literature, when a student observes peers similar to themselves succeed by investing effort, the student is able to believe that they also have the ability to succeed in a similar situation, which can increase self-efficacy (Bandura, 1994). It is possible that students who maintained this perception did not feel this way because they demonstrated a performance goal orientation where they use social comparison standards to make judgements of their own ability. This motivation orientation focuses on demonstrating high ability relative to peers and working to be better than others (Meece et al., 2006). It also further emphasizes the importance of implementing classroom practices such as the formative assessment strategies, which foster the development of a mastery goal orientation.

Feedback without grades. Perceptions of the teachers in this study suggest that the use of feedback without grades motivates students. They believe that feedback provides students with encouragement and recognition. When discussing this strategy in particular, it was the teachers' perceptions that feedback without grades motivated students through the use of formative quizzes. One teacher commented that college level or applied students are motivated because they require encouragement through the identification of the progress they have been making. It is possible that applied level students require more encouragement, because they may have a lower self-efficacy. As Bandura (1994) indicates, self-efficacy beliefs impact motivation. Feedback without grades that identifies progress may provide students with an understanding that they are capable of improving, which fosters positive self-efficacy through verbal persuasion (Bandura, 2012). Consequently, students' motivation may increase. On the other hand, the teacher suggested that senior students are motivated from feedback without grades, because they require feedback to help them focus their attention on the gaps in their understanding. It is possible that these students have a higher self-efficacy, and therefore they require assistance to identify steps to improve more so than encouragement. This need may occur as a result of their motivation being derived from a mastery goal orientation and therefore they are focused on improving and mastering new skills (Cauley & McMillan, 2010). It is also possible that senior students are focused on achieving standards for postsecondary schools. Therefore their motivation may be gained from improving, because they want to meet normative performance standards (Ames & Archer, 1988; Meece et al., 2006), which is representative of a performance goal orientation.

Student perceptions indicated that they perceived feedback without grades to increase their motivation as it identifies the gaps in their learning and provides direction with how to improve and where to focus their efforts. It seems that the use of feedback without grades promotes a mastery goal orientation as the teacher focuses on skill development, mastery, and improvement (Meece et al., 2006). Moreover, feedback without grades motivates students because they feel they are capable of succeeding when their teacher outlines what steps need to be taken to improve their understanding. It seems students' motivation is increased when their self-efficacy is increased. Consistent with the literature, by demonstrating to students what needs to be done to improve, feedback without grades can increase student motivation to do mathematics by promoting a mastery goal orientation, which places emphasis on effort (Black et al., 2004). This goal orientation is further promoted when teachers encourage students to determine success based on their own progress (Meece et al., 2006). Teachers' perceptions seem to indicate that this encouragement occurs when feedback without grades highlights the progress students have been making towards achieving their learning goals.

It was the perception of most students in this study that feedback without grades positively impacted their self-efficacy because they felt reassured and validated about what they are doing correctly. Such validation fosters positive self-efficacy through the source of verbal persuasion (Bandura, 1977). Teachers are conveying positive messages that indicate students are capable. In regards to the gaps students have in their understanding, self-efficacy is positively influenced because the teacher provides direction on how to improve. Student perceptions seem to indicate that feedback without grades has a positive impact on their self-efficacy because they realize that they are

capable of improving if they invest in the effort. This positive impact is indicative of fostering self-efficacy through performance accomplishments. Students experience overcoming failures through perseverance and are encouraged to consider mistakes as learning opportunities instead of something that leaves them demoralized (Bandura, 2012).

Importantly, some students described issues with feedback without grades. It was the perception of one student that if the feedback was perceived to be negative or centering out a student, the feedback would decrease their motivation. Additionally, one student perceived feedback without grades to negatively impact self-efficacy if the feedback was general to all students in the class. This verbal feedback negatively influenced self-efficacy because she felt the mathematical concept was too difficult and, therefore, she would be unable to succeed. In contrast, if other students are succeeding, then this student felt encouraged and that she too had the ability to succeed. This impact of feedback can be attributed to the self-efficacy source of vicarious experience (Bandura, 1977). When students observe peers similar to themselves invest effort and succeed, they believe that they too are capable of success in a similar situation. In contrast, when students observe peers invest effort and fail, their self-efficacy and motivation to invest effort in a similar situation is decreased (Bandura, 1994). Although teachers discuss common errors and misconceptions as means of improving student learning, based on some students' perceptions, it seems that this practice can have a negative influence on some students' motivation and self-efficacy.

Self-assessment. The perceptions of students in this study suggest that the implementation of self-assessment increases students' motivation to do mathematics

because they are able to document and see the progress in their learning. Students' perceptions seem to indicate that students' motivation is increased, because they feel encouraged and want to keep progressing further. This fosters a mastery goal orientation for motivation, which places emphasis on learning, understanding, and improving (Cauley & McMillan, 2010). This finding aligns with current literature, which indicates that by developing mastery goals, the self-efficacy of students is improved (Cauley & McMillan, 2010). In addition, findings indicate that students and teachers find the implementation of self-assessment to be a source of motivation when they are able to recognize what they are doing wrong and determine it is something on which they can improve. This perception reflects a mastery goal orientation because mistakes are treated as part of the learning process (Ames, 1992; Cauley & McMillan, 2010). Similarly, the perceptions of teachers indicate that self-assessment motivates students when the process helps them to understand what the expectations for success are. This is because students are more likely to achieve the expectations and they are able to understand that they have the ability to improve further.

Interestingly, some students in the study suggested that the impact of self-assessment on a student's motivation depends on his or her perception. Motivation can negatively be impacted if students assess themselves negatively instead of focusing on the fact that they did everything they could and will do better next time. Some students indicated that self-assessment negatively influenced their motivation when they continued to do poorly on subsequent assessments despite investing the effort to improve further. These perceptions support existing literature that highlights the influence of the two contrasting approaches to motivation. Students with a mastery goal orientation

persist longer when faced with difficulty and consider mistakes as part of the learning process. In contrast, students with a performance goal orientation attribute failure to a lack of ability and their mistakes elicit anxiety (Ames & Archer, 1988; Elliott & Dweck, 1988; Pajares 2006). It is therefore important for teachers to promote the development of a mastery orientation among students. Formative assessment strategies foster this orientation by treating mistakes as part of the learning process and by providing students with opportunities to improve (Ames, 1992; Cauley & McMillan, 2010).

Perceptions of students in this study indicate that the process of self-assessment can result in positive outcomes for students' self-efficacy. Students expressed that when they are able to document and see their progress, they feel more confident in their ability to be successful at mathematics. Moreover, when students are able to identify what steps they need to take in order to improve, they feel more capable of being successful. They feel more confident for future assessments because they perceive that the gap in their understanding is something that they are able to address. This occurrence in the mathematics classroom is consistent with literature, which discusses the incorporation of self-assessment in classrooms for other subject areas. Through the implementation of self-assessment, students are able to track their growth, which facilitates a sense of control over their learning and positively contributes to their self-efficacy (Cauley & McMillan, 2010; Stiggins, 2002; Stiggins & Chappuis, 2005). Some students perceived self-assessment to positively influence self-efficacy because the process was described to be independent of others and therefore is personal. This perception was prevalent among students who seemed to not have a strong sense of self-efficacy and those who also appeared to fear judgement of others. This finding contributes to existing literature by

demonstrating that students without a strong confidence in their ability to succeed may be more likely to benefit from the sense of control over their own learning, which the process of self-assessment provides.

In contrast, self-assessment can negatively impact students' self-efficacy when they take steps to improve further, but despite their best efforts, they are not successful on subsequent assessments. As part of a person's self-efficacy expectation, the source of performance accomplishments requires that learners be able to deal with failure by using the experience as a learning opportunity instead of being demoralized (Bandura, 2012). It is necessary that through the process of self-assessment, students are encouraged to perceive mistakes as learning opportunities, which is essential in order to develop a resilient self-efficacy.

Peer assessment. Most student perceptions in this study suggest that peer assessment positively impacts their motivation to do mathematics. It appears that receiving feedback from peers increases their motivation to invest effort to improve. Student perceptions indicated that they were motivated because they wanted to experience success like their peers. One teacher's perception suggested that students are motivated because they do not want to be left behind their peers. This can potentially be associated with a performance goal orientation approach to motivation where a focus is placed on demonstrating high ability relative to others and striving to be better than peers (Meece et al., 2006). However, it is important to note that a mastery goal orientation is what is associated with positive academic results, positive academic self-efficacy, and greater cognitive engagement (Meece et al., 2006; Meece et al., 1988; Roeser et al., 1996). It is also important to consider that this increase in motivation, because students

want to experience similar success as peers, could be a consequence of an increased self-efficacy based on the source of vicarious experience. This improved self-efficacy could then, in turn, positively increase students' motivation. Providing peers with feedback increased some students' motivation because they were able to feel like a leader. Students considered working in groups to be more engaging and therefore their motivation is increased. Teacher perceptions also suggested that when working in groups, students are able to encourage each other, which can increase student motivation. This increase in motivation may occur as a result of this encouragement from peers fostering positive self-efficacy through the source of verbal persuasion, which, in turn, positively impacts their motivation (Bandura, 1994; Bandura, 2012).

When considering peer collaboration as a form of peer assessment, one teacher's perception suggested there can be an increase in student motivation as students are less likely to be afraid to participate, and therefore contribute ideas, among small groups of peers. When working in groups, peers are able to provide feedback to each other before submitting a final response. Working in groups may either reassure the student whether he or she is correct or peers can work together to provide a more correct response. It may increase students' motivation because their self-efficacy is improved by reducing the anxiety elicited in the task (Bandura, 1977). Furthermore, if students maintain a performance goal orientation to motivation, they avoid appearing incompetent, which can lead to anxiety (Ames & Archer, 1988; Elliot & Dweck, 1988; Pajares, 2006). By collaborating with peers, this anxiety is reduced and therefore students with this goal orientation may begin to understand that mistakes are part of the learning process. In contrast to other forms of formative assessment, the feedback provided through peer

assessment is more often focused on the collective group, rather than targeted to a particular student. This focus is evident in gallery walks where the feedback is often targeted towards the work of the group as opposed the work of an individual student. As a result, student motivation may increase because there exists less of a threat to their self-efficacy.

The incorporation of peer assessment seems to have a positive influence on students' self-efficacy because their understanding of topics is improved and they are able to help peers learn. Students' perceptions indicated that they were able to learn from peers' work and subsequently implement the process of self-assessment to determine how they can improve their own work. By increasing their understanding of mathematical concepts, students' self-efficacy was consequently increased. Receiving feedback from peers enabled students to identify areas for self-improvement, which increased their belief in their ability to be successful. Similarly, the perceptions of teachers in this study suggest that students' self-efficacy is increased when they view peers being successful or experiencing similar struggles. When observing peers' successes, students may believe that they too can experience similar success and are able to improve their own work further. Aligning with current literature, this impact demonstrates an increase in self-efficacy expectations based on the source of vicarious experience. By observing peers similar to themselves succeed by investing effort, students are able to believe that they also have the ability to succeed (Bandura, 1994). The perceptions of students also seem to show that providing peers with feedback increases their self-efficacy because they are able to feel like a teacher and a leader, which verifies their own skills and understanding while helping peers. Contributing to existing literature, students perceived peer

collaboration during classroom activities to be a form of peer assessment. Some students highlighted that this form of peer assessment increased their self-efficacy because they are able to discuss ideas with peers and to see how others are approaching problems.

Importantly, the perceptions of some students indicated that peer assessment may also negatively influence self-efficacy beliefs. When students are already unconfident in their understanding and they receive feedback from peers, the feedback can be seen as criticism and contribute to a further decrease in the belief of their own ability. Moreover, if students were not confident in their own ability, they did not feel confident to provide peers with feedback.

Formative use of summative assessments. Student perceptions in this study suggest an increase in student motivation through the incorporation of the formative use of summative assessments. Students expressed motivation to improve based on the feedback provided on summative assessments. The feedback on their strengths encourages them, while the feedback on their weaknesses and how they can improve motivates them to invest the effort to do so. The formative use of summative assessment provides further opportunities to improve. Teachers suggested that students' motivation to invest effort is increased when they are provided with the opportunity to improve their summative assessments based on the teacher's feedback. This opportunity supports the development of a mastery goal orientation to motivation, which places emphasis on learning, understanding, improving and mastering new skills (Cauley & McMillan, 2010). The formative use of summative assessment appears to increase motivation because mistakes are treated as part of the learning process and students are provided with opportunities to improve. These practices promote a mastery goal orientation which

is important because this orientation is associated with persisting longer when faced with difficulty (Ames, 1992; Ames & Archer, 1988; Cauley & McMillan, 2010; Elliott & Dweck, 1988; Pajares 2006). Through the incorporation of the formative use of summative assessments, students are motivated to improve their understanding based on the teacher's feedback that is provided. As presented in Chapter 4, some students perceived formative quizzes and practice tests to be the incorporation of the formative use of summative assessments. Students found these forms of this strategy to be motivational because it prepared them for upcoming summative assessments. One student had the perception that this strategy decreased his motivation when he did poorly on a summative assessment. It is possible that this perception occurred as a result of a performance goal orientation from which mistakes are not considered as a part of the learning process (Ames & Archer, 1988).

Students perceived the formative use of summative assessment to positively impact their self-efficacy because they were able to improve upon the gaps in their understanding, which made them feel more confident in their ability moving forward. This benefit was reiterated by teachers who believed that the feedback provided on the summative assessments helped students to feel that they were capable of improving. Moreover, the perceptions of students indicated that even if they were doing poorly, they knew what they needed to improve on, which made them feel capable of improving their understanding. Furthermore, their self-efficacy was improved through the incorporation of this strategy because they felt they were able to learn more. When discussing formative quizzes, one student suggested that without the use of formative assessments, students do not have direction on where to improve. When there are only summative

assessments, students, at the end, find out what the gaps in their understanding are. As a result, the formative quizzes improve students' self-efficacy because they are given direction on where they need to improve and what steps need to be taken to do so. The formative use of summative assessments seems to positively influence student self-efficacy expectations through the sources of performance accomplishments and verbal persuasion. Through the incorporation of this strategy, students are encouraged to deal with failure by using the experience as a learning opportunity and they are given the chance to overcome obstacles through perseverance. Both experiences are necessary in order to develop resilient self-efficacy (Bandura, 2012). Teachers' feedback on students' strengths and weaknesses encourages learners by highlighting what they are doing well and by providing direction to improve their gaps in their learning. When students have direction on how to improve, they are able to feel that they have the ability to be successful. This impact of feedback on summative assessments pertains to the source of verbal persuasion, which encompasses the messages conveyed by others (Bandura, 2012). However, it is important to note that one student had the perception that the formative use of summative assessments can decrease students' self-efficacy when they review their marked summative assessment and they did poorly. This outcome can cause students to question their ability to be successful at mathematics. It seems that students with this perception fail to see these experiences as learning opportunities and instead become demoralized.

This study provides a detailed account of the impact of each formative assessment strategy on student motivation and self-efficacy. Because each strategy has its own role in the classroom, it is not surprising that each strategy impacts motivation and self-efficacy

in its own way; however, similar to the way formative assessment strategies have a common goal of improving student learning, there are commonalities among the impact of these strategies. Overall, the formative assessment strategies appear to positively impact the self-efficacy and motivation of mathematics students.

Influence of the Connection between Self-Efficacy and Motivation

The impact of the implementation of formative assessment strategies on student motivation and self-efficacy seems to be influenced by the underlying connection between motivation and self-efficacy. Students' perceptions indicated that self-efficacy impacted some students' motivation and, similarly, that student motivation impacted students' self-efficacy. Most commonly, it seems that student self-efficacy impacts their motivation to do mathematics. This finding aligns with literature on self-efficacy because how an individual feels, thinks, behaves, and is motivated is impacted by his or her self-efficacy beliefs (Bandura, 1994). The perceptions of students suggest that if they perceive themselves to be capable of succeeding at mathematics, they were more motivated. Conversely, if students did not believe that they were capable of being successful, their motivation was decreased. Students with a strong belief in their ability to be successful at mathematics seemed to be, overall, more motivated than those that did not have confidence in their ability. Findings are consistent with the self-efficacy theory, which maintains that self-efficacy is a determinant of motivation because a person's self-efficacy impacts how much effort is invested when faced with a challenge and how long he or she will persevere (Bandura, 1989).

This connection between motivation and self-efficacy appears to occur because how well a student is doing is a source of both motivation and self-efficacy. This is the

case particularly when students consider their grades. Some students indicated that they consistently did well in mathematics and, as a result, were highly motivated even if they received some low marks. In contrast, students' perceptions indicated that when they invest effort and do poorly, particularly on summative assessments, their motivation to do mathematics is decreased. A lack of or a decreased motivation to do mathematics as a result of receiving poor marks in a course can also impact students' motivation in subsequent years. Therefore, students' past experiences and grades in mathematics can negatively influence their self-efficacy and as a result decrease their motivation.

This connection between motivation and self-efficacy appears to influence the impact that formative assessment strategies can have. It may take more time for students with negative self-efficacy or a performance goal orientation to be positively influenced by formative assessment strategies. It may also take longer to reinforce the idea that the feedback provided through the incorporation of strategies is not negative criticism. Instead, the feedback is intended to identify the gaps in understanding and the steps that can be taken to improve. A performance goal orientation is associated with attributing failure to a lack of ability and mistakenly eliciting anxiety (Ames & Archer, 1988; Pajares, 2006). However, it is necessary that learners are able to deal with failure by using the experience as a learning opportunity rather than being demoralized in order to develop a positive self-efficacy (Bandura, 2012). It is also important to note that how students interpret their bad mark affects how the mark will impact their self-efficacy. If students see that the gap in their understanding is something on which they are able to improve or is not far from their goals, the low mark is less likely to negatively impact their self-efficacy and motivation. In order for the implementation of formative

assessment strategies to have a positive impact, students must be able to see mistakes as a learning opportunity, which is associated with a mastery goal orientation as well as positive self-efficacy (Ames & Archer, 1988; Bandura, 2012). Furthermore, because grades are a source of both student motivation and self-efficacy, it may take repeated experiences for students to understand the purpose and benefit of formative assessment strategies. The incorporation of the formative assessment strategies places emphasis on feedback instead of grades.

Findings from this study, as well as from Volante and Beckett (2011), highlight the belief that teachers face challenges with providing feedback without grades at the secondary level. However, it is necessary to place emphasis on feedback as opposed to grades in an effort to ensure that assessment is viewed as a step in the learning process rather than a competition or summative judgement (Black et al., 2004). The impact of formative assessment strategies is affected by the connection between student motivation and self-efficacy; namely, the connection that how well a student is doing in the course is a source of both. Although the connection between students' self-efficacy and motivation influences the impact of formative assessment, it is necessary that teachers continue to incorporate the strategies into their practice even if they are faced with difficulties as a result of this connection. A classroom where formative assessment is implemented in practice creates opportunities to foster a positive self-efficacy and a mastery goal orientation among students.

Implications

This section addresses applications of this study's findings in terms of practice, theory, and future research. The significance of implementing formative assessment strategies are outlined along with suggestions for improvement.

Implications for Practice

The findings of this study demonstrate implications for practice in terms of educators, higher education, and policy developers. Overall, one of the important implications of this study is an enhanced understanding of the perception of students on the implementation of formative assessment strategies. This insight into the perceptions of students is particularly relevant for practice, because it is not often that students' voices are represented when evaluating assessment practices (Kirton et al., 2007; Miller & Lavin, 2007). It is essential to consider their perception in relation to a topic that is relevant to their success with mathematics.

Implications for educators include the perceptions of students and teachers on the impact of formative assessment practices and, consequently, an understanding of how strategies improve student motivation and self-efficacy, which leads to achievement in mathematics. As a teacher participant stated, educators are faced with a diverse cliental of learners. Students are affected differently by assessment practices; however, this study suggests that overall formative assessment strategies positively impact student motivation and self-efficacy. Self-efficacy and motivation are positively impacted, because formative assessment strategies provide feedback, which offers students encouragement and recognition by highlighting the progress that has been made and what steps need to be taken to improve further. When implementing formative assessment strategies in

practice, educators should place emphasis on providing descriptive feedback in a timely manner in order to help students improve their learning. This study also suggests that there are some considerations that influence how students are impacted by formative assessment strategies. This includes how students perceive mistakes and whether they fear judgement from peers and/or teachers. It is necessary that teachers take these factors into consideration when incorporating formative assessment. For example, when dealing with students who appear to perceive mistakes negatively or as something to be ignored, additional time may be required to modify their thinking to view mistakes as a learning experience. Extra care may need to be taken by the teacher to ensure that feedback is stated in a positive way that emphasizes manageable steps for the student to pursue.

Furthermore, this study provides educators with an understanding of how formative assessment strategies are implemented in practice, specifically within the context of the secondary mathematics classroom. Findings offered additional interpretations and examples of implementation, which educators can adapt into their own classroom practices. This study suggests that the impact of formative assessment strategies has not yet reached its full potential as gaps still exist in its implementation. As findings from this research and previous studies highlight, teachers still struggle with the implementation of peer and self-assessment in the mathematics classroom. It is necessary for teachers to engage in dialogue about effective assessment and evaluation as well as have the opportunity to observe one another in practice. This finding can inform the development of teacher education by potentially influencing how assessment practices are taught to teacher candidates within a teacher education program. Courses for prospective mathematics teachers can further examine how formative assessment can be

implemented with an increased focus on peer and self-assessment. As Volante and Beckett (2011) discovered in their study of Ontario educators, several teachers indicated that their primary source of professional development was from a faculty of education. This claim by practicing teachers supports the importance of the role of teacher education programs in creating greater synergy between formative assessment research and classroom practice.

This study proposes factors that can further support the implementation of formative assessment strategies in the secondary mathematics classrooms. Results of the study point to the importance of strong administrative and departmental leadership to assist teachers in effectively incorporating formative assessment. Strong leadership can promote teacher collaboration, which findings from this study indicate helps teachers to successfully implement formative assessment. Hence, those within leadership roles should encourage and provide opportunities for teachers within the mathematics department to discuss and work together to implement assessment strategies for the purpose of promoting student learning. Teachers can engage in dialogue about effective assessment and evaluation, which can also help to minimize teacher misconceptions about formative assessment which this study revealed to hinder implementation. Moreover, by collaborating to create formative assessment opportunities or activities, the time commitment required for implementation can be reduced. This is another factor that this study demonstrated as an obstacle to implementation. This study also underlines the point that it is essential for students to understand that the purpose of formative assessment is to improve student learning so that they are more likely to take formative assessment seriously. More specifically, in regards to the use of feedback without grades

on quizzes, it is essential for educators to help students understand that the feedback provided will help them improve their understanding. This study, along with past literature, highlights the importance students place on marks. This study suggests that this focus on marks is particularly the case for students in senior grades who are concerned with acceptance to postsecondary programs. Educators must help students to understand that assessment is a step in the learning process rather than a summative judgement. This finding also has implications for developing informed professional development to support teachers in addressing the issues surrounding the implementation of formative assessment.

Implications for Theory

This study extends research undertaken by others regarding the implementation of formative assessment. Volante and Beckett (2011) indicated a need to connect research on formative assessment with classroom practices. This study offers an enhanced understanding of how formative assessment is incorporated in practice, specifically within secondary school mathematics classrooms. The study provides a better understanding of the way teachers and students perceive formative assessment strategies; that is, as a process where strategies are interconnected rather than a set of distinct strategies. For instance, students in this study discussed the relationship between the formative use of summative assessment, self-assessment, and feedback without grades. Teachers in this study addressed several connections including the relationship between the strategies of feedback without grades and questioning techniques implemented during classroom discussions. Teachers and students presented diverse interpretations of implementation that contributed to the existing literature. For example, one contribution

includes the consideration of a self-assessment opportunity as providing students with choice about which questions they choose to answer on formative quizzes or summative assessments. This study highlights the role of the teacher, teaching environment, and student in the implementation of formative assessment. Some considerations include the impact of teachers' personal philosophies, interpretations of policy documents, and personal experiences as well as leadership within the school, teacher collaboration, and student understanding of the purpose of formative assessment.

From the review of literature, studies that include student perceptions in the area of formative assessment are limited (Kirton et al., 2007; Miller & Lavin, 2007). This study contributes to the theory on formative assessment by providing an understanding of the perceptions of students at the secondary school mathematics level regarding the implementation and impact of formative assessment. A desire to voice students' perspectives was one of the reasons behind the rationale of this research. It is essential to have an understanding of students' perceptions of the impact on self-efficacy and motivation as both are considered important factors for student success (Nasiriyah et al., 2011; Zientek & Thompson, 2010). The importance of the student perceptions is extended by the result of this study that indicates that teachers find difficulty in evaluating the impact of formative assessment on student motivation and self-efficacy.

The theoretical framework for this study is social cognitive theory and achievement goal theory. This study contributes to the theory on self-efficacy and motivation. This study provides an understanding that the impact of formative assessment strategies is influenced by the connection between motivation and self-efficacy, that is, how well a student is doing in a course is a source of both concepts. This includes, but is

not limited to, the marks that the student is achieving. This study extends existing theory on self-efficacy and motivation, by specifically considering how this connection influences assessment practices, namely the impact of formative assessment strategies.

This research also contributes to achievement goal theory in regards to the perceptions of the impact on motivation when students make comparisons to peers. When discussing the impact of questioning techniques and peer assessment on student motivation, some students indicated that they experienced increased motivation, because they wanted to experience success like peers. Correspondingly, one teacher perceived that students were motivated through peer assessment because they did not want to be left behind their peers. From the achievement goal theory, the performance goal orientation represents a focus on demonstrating high ability relative to peers and working to be better than others (Meece et al., 2006). Ability is demonstrated by performing better than others (Ames & Archer, 1988). Consequently, these findings of students gaining motivation from comparisons to peers may be attributed to a performance goal orientation. However, this goal orientation is associated with negative results including avoiding challenging tasks (Dweck & Leggett, 1988; Elliott & Dweck, 1988), avoiding help seeking, and attributing failure to a lack of ability (Pajares, 2006), while, in contrast, a focus on mastery goals has been associated with positive academic results (Ames, 1992; Meece et al., 2006). It is also important to consider that this increase in motivation, because students want to experience similar success as peers, could be a result of an increased self-efficacy based on the source of vicarious experience. This source involves observing others similar to oneself perform tasks and taking note of the resulting consequences (Bandura, 1977). By observing peers similar to themselves succeed, students are able to

believe that they also have the ability to succeed (Bandura, 1994). This improved self-efficacy could then positively impact students' motivation. These findings also align with results that exemplified a positive influence on self-efficacy when students make comparisons to peers through the implementation of questioning techniques, feedback without grades, and peer assessment, which can be attributed to vicarious experience. These findings extend current literature by presenting positive results of comparisons to peers, normally associated with a performance goal orientation, and further exemplifying the connection between motivation and self-efficacy.

Implications for Further Research

Although additional research is needed in order to further understand the implementation and impact of formative assessment strategies, some specific suggestions with respect to additional projects can be made. Future research should utilize a larger sample size that will allow for a detailed analysis of the impact of formative assessment strategies in terms of the age of students. Results of this study indicated that some differences existed with senior students such as the emphasis placed on grades. Further research could explore the difference in impact of formative assessment based on students' grade level. In addition, a larger sample size could allow for analysis of gender differences. This study did not examine gender differences in the impact of formative assessment; however, it is believed that this merits further research. Moreover, a larger sample size would allow for more teachers to be studied, which may provide further examples of implementation. This focus could potentially fill the gap on understanding how peer and self-assessment can be incorporated in the secondary mathematics classroom.

This study suggests that strong leadership is valuable in implementing formative assessment strategies. Subsequent research should further examine the role that leadership plays in the incorporation of formative assessment strategies. In addition, this research could examine what professional development is available for teachers that would promote the use of these assessment strategies, specifically within the mathematics classrooms. Similarly, future research should also examine whether and how teacher education programs are enabling future teachers with the pedagogical content knowledge necessary to implement formative assessment strategies in mathematics classrooms. Is there a focus on assessment for learning when discussing assessment and evaluation? Are lessons targeted towards specific subjects that teacher candidates will be teaching? In order for formative assessment to reach its full potential, it is necessary that teachers have the knowledge of how to effectively implement the assessment strategies. Future research could examine whether teacher education programs are providing prospective teachers with this essential knowledge.

The comments of one teacher participant in regards to the tradition of mathematics have left a lasting impression and merits further research. As discussed in Chapter 4, she expressed the point that mathematics has a “long, established tradition and there is this real belief that this is the way it should be done, this is the right way and if we change it, we are going to be diminishing it in some form.” Do other teachers share this same perception? If so, what are the implications of this perception? Is this the case for secondary mathematics or possibly primarily postsecondary mathematics? It would be beneficial for future research to examine this point further.

The findings of this study suggest that the connection between self-efficacy and motivation appears to influence the impact of formative assessment strategies. With this in mind, further research should explore how the relationship among self-efficacy and motivation relates to formative assessment particularly within the secondary mathematics classroom.

Conclusion and Final Thoughts

This study aimed to explore the potential of formative assessment to fulfill Stiggins's (2007) vision of assessment: one that fosters confidence, motivation, and learning among all students. The findings of this study suggest that, overall, formative assessment strategies positively impact the motivation and self-efficacy of secondary school mathematics students. This impact occurs because the strategies provide feedback, which offers students encouragement and recognition by highlighting the progress that has been made and what steps need to be taken to improve. Consequently, this insight helps students feel that they are capable of succeeding. This is particularly important within the mathematics classroom, because as discussed in Chapter 1, a societal belief appears to exist regarding success in mathematics being limited to those with an innate ability (Ontario Ministry of Education, 2004). *The Report of the Expert Panel on Student Success in Ontario* on mathematical literacy called for a shift in the way assessment is perceived, which includes a focus on assessment for the purpose of improving learning (Ontario Ministry of Education, 2004). More recently, *Growing Success* emphasized that the primary purpose of assessment is to improve student learning (Ontario Ministry of Education, 2010). Although formative assessment has the capability of fulfilling Stiggins's vision and those within the Ontario Ministry of Education's documents, as this

study and past research suggest, teachers struggle with the effective implementation of strategies such as self-assessment and peer assessment. There still exists a need to continue research within this area of assessment. Taking into consideration my personal experiences, existing literature, and findings of this current study, this area of research will continue to be a critical area for further investigation in the future.

References

- Adediwura, A. A. (2012). Effects of peer and self-assessment on male and female students' self-efficacy and self-autonomy in the learning of mathematics. *Gender and Behaviour*, 10(1), 4492–4508. Retrieved from <http://ajol.info/index.php/gab/index>
- Ames, C. (1992). Classrooms: Goals, structures, and student motivation. *Journal of Educational Psychology*, 84(3), 261–271. doi:10.1037/0022-0663.84.3.261
- Ames, C. & Archer, J. (1988). Achievement goals in the classroom: Students' learning strategies and motivation processes. *Journal of Educational Psychology*, 80(3), 260–267. doi:10.1037/0022-0663.80.3.260
- Andrade, H. L. & Cizek, G. J. (Eds.). (2010). *Handbook of formative assessment*. New York, NY: Routledge.
- Assessment Reform Group. (2002). *Assessment for learning: 10 principles*. Retrieved from <http://www.assessment-reform-group.org/publications.html>
- Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, 84(2), 191–215. doi:10.1037/0033-295X.84.2.191
- Bandura, A. (1989). Human agency in social cognitive theory. *American Psychologist*, 44(9), 1175–1184. doi:10.1037/0003-066X.44.9.1175
- Bandura, A. (1994). Self-efficacy. In V. S. Ramachaudran (Ed.), *Encyclopedia of human behavior* (Vol. 4, pp. 71-81). San Diego, CA: Academic Press.
- Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York, NY: W. H. Freeman and Company.

- Bandura, A. (2012). On the functional properties of perceived self-efficacy revisited. *Journal of Management*, 38(1), 9–44. doi:10.1177/0149206311410606
- Black, P., Harrison, C., Lee, C., Marshall, B., & Wiliam, D. (2004). Working inside the black box: Assessment for learning in the classroom. *Phi Delta Kappan*, 86(1), 8–21. doi:10.2307/20441694
- Black, P., & Wiliam, D. (1998a). Assessment and classroom learning. *Assessment in Education*, 5(1), 7–74. doi:10.1080/0969595980050102
- Black, P., & Wiliam, D. (1998b). Inside the black box: Raising standards through classroom assessment. *Phi Delta Kappan*, 80(2), 139–148. doi:10.2307/20439383
- Black, P., & Wiliam, D. (2004). The formative purpose: Assessment must first promote learning. In M. Wilson (Ed.), *Towards coherence between classroom assessment and accountability* (pp. 20–50). Chicago, IL: University of Chicago Press.
- Brown, G. T. L. (2004). Teachers' conceptions of assessment: Implications for policy and professional development. *Assessment in Education*, 11 (3), 301–318. doi:10.1080/096959402000304609
- Bumgarner, J. (Writer) & Cohen, M. (Director). (2009). Episode #4.7 [Television series episode]. In M. Davies (Executive Producer), *Who Wants to Be a Millionaire*. New York, NY: American Broadcasting Company.
- Cauley, K. M., & McMillan, J. H. (2010). Formative assessment techniques to support student motivation and achievement. *The Clearing House*, 83(1), 1–6. doi:10.1080/00098650903267784

- Chan, J. C., & Lam, S. (2010). Effects of different evaluative feedback on students' self-efficacy in learning. *Instructional Science*, 38(1), 37–58. doi:10.1007/s11251-008-9077-2
- Creswell, J. W. (2012). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (4th ed.). Boston, MA: Pearson Education.
- Creswell, J. W., & Plano Clark, V. L. (2007). *Designing and conducting mixed methods research*. Thousand Oaks, CA: Sage.
- Creswell, J. W., Plano Clark, V. L., Gutmann, M. L., & Hanson, W. E. (2003). Advanced mixed methods research designs. In A. Tashakkori & C. Teddlie (Eds.), *Handbook of mixed methods in social and behavioral research* (pp. 209–240). Thousand Oaks, CA: Sage.
- Crooks, R. J. (1988). The impact of classroom evaluation practices on students. *Review of Educational Research*, 58(4), 438–481. doi:10.3102/00346543058004438
- Dweck, C. S., & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. *Psychological Review*, 95(2), 256–273. doi:10.1037/0033-295X.95.2.256
- Earl, L., & Katz, S. (2006). *Rethinking classroom assessment with a purpose in mind*. Retrieved from http://www.edu.gov.mb.ca/k12/assess/wncp/rethinking_assess_mb.pdf
- Elliot, E. S., & Dweck, C. S. (1988). Goals: An approach to motivation and achievement. *Journal of Personality and Social Psychology*, 54(1), 5–12. doi:10.1037/0022-3514.54.1.5

- Hughes, G. B. (2010). Formative assessment practices that maximize learning for students at risk. In H. Andrade & G. Cizek (Eds.), *Handbook of formative assessment* (pp. 212–232). New York, NY: Routledge.
- Ivankova, N. V., Creswell, J. W., & Stick, S. L. (2006). Using mixed-methods sequential explanatory design: From theory to practice. *Field Methods*, 18(1), 3–20.
doi:10.1177/1525822X05282260
- Jones, A., & Morland, J. (2005). The importance of pedagogical content knowledge in assessment for learning practices: A case-study of a whole-school approach. *The Curriculum Journal*, 16(2), 193–206. doi:10.1080/09585170500136044
- Kingston, N., & Nash, B. (2011). Formative assessment: A meta-analysis and a call for research. *Educational Measurement: Issues and Practice*, 30(4), 28–37.
doi:10.1111/j.1745-3992.2011.00220.x
- Kirton, A., Hallam, S., Peffers, J., Robertson, P., & Stobart, G. (2007). Revolution, evolution or a Trojan horse? Piloting assessment for learning in some Scottish primary schools. *British Educational Research Journal*, 33(4), 605–627.
doi:10.1080/01411920701434136
- Literacy and Numeracy Secretariat. (2010, September). Communication in the mathematics classroom. *Capacity Building Series*, 13. Retrieved from <http://www.edu.gov.on.ca/>
- Literacy and Numeracy Secretariat. (2011). *The three-part lesson in mathematics: Co-planning, co-teaching and supporting student learning*. Toronto, ON: Queen's Printer for Ontario.

- Maehr, M. L., & Midgley, C. (1991). Enhancing student motivation: A schoolwide approach. *Educational Psychologist*, 26(3-4), 399–427.
doi:10.1080/00461520.1991.9653140
- Maehr, M. L., & Zusho, A. (2009). Achievement goal theory. In K. R. Wentzel & A. Wigfield (Eds.), *Handbook of motivation at school* (pp. 77–104). New York, NY: Routledge Taylor & Francis Group.
- McCarty, M. (1993). Teen talk Barbie. *The Mathematics Teacher*, 86(1), 4.
- McMillan, J. H., Cohen, J., Abrams, L., Cauley, K., Pannozzo, G., & Hearn, J. (2010). *Understanding secondary teachers' formative assessment practices and their relationship to student motivation*. Richmond, VA: Metropolitan Educational Research Consortium.
- McMillan, J. H., & Turner, A. B. (2014, April). *Understanding student voices about assessment: Links to learning and motivation*. Paper presented at the meeting of the American Educational Research Association, Philadelphia, PA.
- Meece, J. L., Anderman, E. M., & Anderman, L. H. (2006). Classroom goal structure, student motivation, and academic achievement. *Annual Review of Psychology*, 57, 487–503. doi:10.1146/annurev.psych.56.091103.070258
- Meece, J. L., Blumenfeld, P. C., & Hoyle, R. H. (1988). Students' goal orientations and cognitive engagement in classroom activities. *Journal of Educational Psychology*, 80(4), 514–523. doi:10.1037/0022-0663.80.4.514
- Miller, D., & Lavin, F. (2007). “But now I feel I want to give it a try”: Formative assessment, self-esteem and a sense of competence. *The Curriculum Journal*, 18(1), 3–25. doi:10.1080/09585170701292109

- Murtagh, L. (2014). The motivational paradox of feedback: Teacher and student perceptions. *Curriculum Journal*, 25(4), 516–541.
doi:0.1080/09585176.2014.944197
- Nasiriyani, A., Azar, H. K., Noruzy, A., & Dalvand, M. R. (2011). A model of self-efficacy, task value, achievement goals effort and mathematics achievement. *International Journal of Academic Research*, 3(2), 612–618. Retrieved from <http://www.ijar.lit.az/>
- Natriello, G. (1987). The impact of evaluation processes on students. *Educational Psychologist*, 22(2), 155–175. doi:10.1207/s15326985ep2202_4
- Neuman, W. L., & Robson, K. (2009). *Basics of social research*. Toronto, ON: Pearson Education Canada.
- Nicholls, J. G. (1984). Achievement motivation: Conceptions of ability, subjective experience, task choice, and performance. *Psychological Review*, 91(3), 328–346.
doi:10.1037/0033-295X.91.3.328
- Ontario Ministry of Education. (2004). *Leading math success: Mathematical literacy, grades 7-12: The report of the expert panel on student success in Ontario*. Toronto, ON: Queen's Printer for Ontario.
- Ontario Ministry of Education. (2005). *The Ontario curriculum grades 9 and 10 mathematics revised*. Toronto, ON: Queen's Printer for Ontario.
- Ontario Ministry of Education. (2007). *The Ontario curriculum grades 11 and 12 mathematics revised*. Toronto, ON: Queen's Printer for Ontario.
- Ontario Ministry of Education. (2010). *Growing success: Assessment, evaluation and reporting in Ontario schools*. Toronto, ON: Queen's Printer for Ontario.

- Pajares, F. (2006). Self-efficacy during childhood and adolescence: Implications for teachers and parents. In F. Pajares & T. Urdan (Eds.), *Self-efficacy beliefs of adolescents* (pp. 339–367). Greenwich, CT: Information Age.
- Peterson, E. R., & Irving, S. E. (2008). Secondary school students' conceptions of assessment and feedback. *Learning and Instruction*, 18(3), 238–250.
doi:10.1016/j.learninstruc.2007.05.001
- Plenty, S., & Heubeck, B. G. (2011). Mathematics motivation and engagement: An independent evaluation of a complex model with Australian rural high school students. *Educational Research and Evaluation*, 17(4), 283–299.
doi:10.1080/13803611.2011.622504
- Rakoczy, K., Klieme, E., Bürgermeister, A., & Harks, B. (2008). The interplay between student evaluation and instruction. *Journal of Psychology*, 216(2), 111–124.
doi:10.1027/0044-3409.216.2.111
- Roeser, R. W., Midgley, C., & Urdan, T. C. (1996). Perceptions of the school psychological environment and early adolescents' psychological and behavioral functioning in school: The mediating role of goals and belonging. *Journal of Educational Psychology*, 88(3), 408–422. doi: 10.1037/0022-0663.88.3.408
- Stiggins, R. J. (2002). Assessment crisis: The absence of assessment for learning. *Phi Delta Kappan*, 83(10), 758–765. doi:10.2307/20440249
- Stiggins, R. J. (2005). From formative assessment to assessment for learning: A path to success in standards-based schools. *Phi Delta Kappan*, 87(4), 324–328.
doi:10.2307/20441998

- Stiggins, R. J. (2007). Assessment through the student's eyes. *Educational Leadership*, 64(8), 22–26. Retrieved from www.ascd.org/el
- Stiggins, R. J. (2010). Essential formative assessment competencies for teachers and school leaders. In H. Andrade & G. Cizek (Eds.), *Handbook of formative assessment* (pp. 233–250). New York, NY: Routledge.
- Stiggins, R., & Chappuis, J. (2005). Using student-involved classroom assessment to close achievement gaps. *Theory Into Practice*, 44(1), 11–18.
doi:10.1207/s15430421tip4401_3
- Suurtamm, C., Koch, M., & Arden, A. (2010). Teachers' assessment practices in mathematics: Classrooms in the context of reform. *Assessment in Education: Principles, Policy & Practice*, 17(4), 399–417.
doi:10.1080/0969594X.2010.497469
- Tanner, H., & Jones, S. (2003). Self-efficacy in mathematics and students' use of self-regulated learning strategies during assessment events. In N. A. Pateman, B. J. Dougherty, & J. T. Zilliox (Eds.), *Proceedings of the 2003 Joint Meeting of PME and PMENA: Vol. 4* (pp. 275–282). Retrieved from <http://www.igpme.org>
- Volante, L., & Beckett, D. (2011). Formative assessment and the contemporary classroom: Synergies and tensions between research and practice. *Canadian Journal of Education*, 34(2), 239–255. Retrieved from <http://www.csse-scee.ca/csse/cje>

- Yin, Y., Shavelson, R. J., Ayala, C. C., Ruiz-Primo, M. A., Brandon, P. R., Furtak, E. M., Tomita, M. K., & Young, D. B. (2008). On the impact of formative assessment on student motivation, achievement, and conceptual change. *Applied Measurement in Educations*, 21(4), 335–359. doi:10.1080/08957340802347845
- Zientek, L. R. & Thompson, B. (2010). Using commonality analysis to quantify contributions that self-efficacy and motivational factors make in mathematics performance. *Research in the Schools*, 17(1), 1–11. Retrieved from <http://www.msstate.edu/org/msera/rits.htm>

Appendix A

Questionnaire

Part One: *Thinking about your views on mathematics.*

To what extent do you agree with the following statements? Please only fill in one circle in each row.

1) I look forward to doing mathematics.

<i>Strongly Agree</i>	<i>Agree</i>	<i>Neutral</i>	<i>Disagree</i>	<i>Strongly Disagree</i>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

2) I believe I am capable at doing well in mathematics.

<i>Strongly Agree</i>	<i>Agree</i>	<i>Neutral</i>	<i>Disagree</i>	<i>Strongly Disagree</i>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

3) I feel helpless when working on mathematics.

<i>Strongly Agree</i>	<i>Agree</i>	<i>Neutral</i>	<i>Disagree</i>	<i>Strongly Disagree</i>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

4) I get stressed easily when I have to work on mathematics.

<i>Strongly Agree</i>	<i>Agree</i>	<i>Neutral</i>	<i>Disagree</i>	<i>Strongly Disagree</i>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

5) I believe that I have a lot of weaknesses in mathematics.

<i>Strongly Agree</i>	<i>Agree</i>	<i>Neutral</i>	<i>Disagree</i>	<i>Strongly Disagree</i>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

6) My teachers see me as someone who is good in mathematics.

<i>Strongly Agree</i>	<i>Agree</i>	<i>Neutral</i>	<i>Disagree</i>	<i>Strongly Disagree</i>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

7) Other students see me as someone who is good in mathematics.

<i>Strongly Agree</i>	<i>Agree</i>	<i>Neutral</i>	<i>Disagree</i>	<i>Strongly Disagree</i>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

8) I do not feel sure about myself when I am doing mathematics.

<i>Strongly Agree</i>	<i>Agree</i>	<i>Neutral</i>	<i>Disagree</i>	<i>Strongly Disagree</i>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

9) When I start solving a problem, I usually feel that I will not be able to get the right answer.

<i>Strongly Agree</i>	<i>Agree</i>	<i>Neutral</i>	<i>Disagree</i>	<i>Strongly Disagree</i>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

10) I can solve most math problems if I try hard enough.

<i>Strongly Agree</i>	<i>Agree</i>	<i>Neutral</i>	<i>Disagree</i>	<i>Strongly Disagree</i>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

11) I believe that making an effort in mathematics is worth it.

<i>Strongly Agree</i>	<i>Agree</i>	<i>Neutral</i>	<i>Disagree</i>	<i>Strongly Disagree</i>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Part Two: Thinking about the assessment in your mathematics class.

To what extent do you agree with the following statements? Please only fill in one circle in each row.

1) I feel motivated to respond to a question in class when I am given time to think before having to answer.

<i>Strongly Agree</i>	<i>Agree</i>	<i>Neutral</i>	<i>Disagree</i>	<i>Strongly Disagree</i>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

2) I am motivated to participate in classroom discussions when I know my teacher is not looking for a right answer, but instead is interested in my thinking.

<i>Strongly Agree</i>	<i>Agree</i>	<i>Neutral</i>	<i>Disagree</i>	<i>Strongly Disagree</i>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

3) I am more confident in my ability to do mathematics when I am encouraged to express and discuss my thinking in classroom discussions.

<i>Strongly Agree</i>	<i>Agree</i>	<i>Neutral</i>	<i>Disagree</i>	<i>Strongly Disagree</i>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

4) When I have the chance to improve my assignments based on my teacher's comments, I feel I am able to improve as a mathematics student.

<i>Strongly Agree</i>	<i>Agree</i>	<i>Neutral</i>	<i>Disagree</i>	<i>Strongly Disagree</i>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

5) When I have the chance to review my assignments and tests to determine what I need to do to improve for next time, I am more motivated to invest effort to improve.

<i>Strongly Agree</i>	<i>Agree</i>	<i>Neutral</i>	<i>Disagree</i>	<i>Strongly Disagree</i>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

For the following questions, consider feedback as your teacher's written or verbal comments addressing what has been done well and what needs to be improved on in your work.

6) When my teacher gives me detailed feedback on how to improve, I feel that I am able to succeed.

<i>Strongly Agree</i>	<i>Agree</i>	<i>Neutral</i>	<i>Disagree</i>	<i>Strongly Disagree</i>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

7) When my teacher gives me feedback on how to improve, I am more likely to put in the effort to improve.

<i>Strongly Agree</i>	<i>Agree</i>	<i>Neutral</i>	<i>Disagree</i>	<i>Strongly Disagree</i>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

8) I find my teacher's comments on what still needs improvement in my work as motivation to improve.

<i>Strongly Agree</i>	<i>Agree</i>	<i>Neutral</i>	<i>Disagree</i>	<i>Strongly Disagree</i>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

9) I feel more confident in my ability to do mathematics when I am given feedback on what I need to do to improve.

Strongly Agree *Agree* *Neutral* *Disagree* *Strongly Disagree*
☐ ☐ ☐ ☐ ☐

For the following questions, consider self-assessment as activities such as traffic lights, individual self-assessment sheets, exit cards, and comparing current work to past work.

10) I find participating in self-assessment helps me understand learning goals better.

Strongly Agree *Agree* *Neutral* *Disagree* *Strongly Disagree*
☐ ☐ ☐ ☐ ☐

11) I have more confidence in my ability to do mathematics when self-assessment activities help me keep track of my progress.

Strongly Agree *Agree* *Neutral* *Disagree* *Strongly Disagree*
☐ ☐ ☐ ☐ ☐

12) By participating in self-assessment activities, I feel more in control of my own learning.

Strongly Agree *Agree* *Neutral* *Disagree* *Strongly Disagree*
☐ ☐ ☐ ☐ ☐

13) Self-assessment activities encourage me to determine how successful I am by focusing on my own improvement.

Strongly Agree *Agree* *Neutral* *Disagree* *Strongly Disagree*
☐ ☐ ☐ ☐ ☐

For the following questions, consider peer assessment as activities such as peer marking.

14) Being involved in peer assessment helps me understand learning goals better.

Strongly Agree *Agree* *Neutral* *Disagree* *Strongly Disagree*
☐ ☐ ☐ ☐ ☐

15) Participating in peer-assessment activities help me become better at assessing my own progress.

Strongly Agree *Agree* *Neutral* *Disagree* *Strongly Disagree*
☐ ☐ ☐ ☐ ☐

16) When another student gives me feedback on my work, I feel motivated to make the suggested changes.

Strongly Agree *Agree* *Neutral* *Disagree* *Strongly Disagree*
☐ ☐ ☐ ☐ ☐

Appendix B

Student Interview Questions and Verbal Script

My name is Assuntina Del Gobbo and I am a Master of Education student at Brock University. Thank you very much for volunteering to participate in the interview for this study. I will be asking questions about how your teacher uses formative assessment in your mathematics classroom and how it affects you. I will be following up with questions and prompting you to give examples and details whenever needed. Please feel free to ask me for any clarifications if you do not understand the question. Please note that participation is voluntary and study results will not appear in any school records. The study results will be reported in ways that ensure complete confidentiality.

- 1) On a scale of 1 to 10, where would you rank your experiences in your mathematics class? (10 being very positive and 1 being very negative) Why?
- 2) Can you describe your motivation to do mathematics? Do you look forward to doing mathematics?
- 3) Do you believe that you are capable of doing well at mathematics? Are you confident in your ability to do mathematics?

I am now going to ask you about different strategies your teacher uses to help both her and you to understand your progress and what steps need to be taken to help you improve. For example, classroom discussions, self-assessment activities, etc. I want to learn how these strategies affect you. *[Example of probing questions if required: Could you give me an example of when you felt this way? Why do you think this strategy made you feel that way?]*

The first way is how your teacher asks questions and develops class discussion. This is when your teacher is not necessarily looking for a right answer but rather, is interested in your thinking and encourages you to express and discuss your thinking.

- 4) When your teacher does this, how does it make you feel? How does it affect your motivation to do mathematics? Does it make you feel that you are capable of doing well at mathematics?

The next way is how your teacher uses assessments like quizzes, tests, and assignments. This is when you are given the chance to review your assignments and tests to determine what needs to be done to improve for next time or the opportunity to improve your work based on your teacher's comments.

- 5) When you are given this chance, how does it make you feel? How does it affect your motivation to do mathematics? Does it make you feel that you are capable of doing well at mathematics?

The next way is when your teacher gives you detailed feedback. This is when your teacher gives you written or verbal comments that address what has been done well, what still needs to be improved on, and what steps need to be taken to improve.

- 6) When you are given this detailed feedback, how does it make you feel? How does it affect your motivation? Does it make you feel that you are capable of doing well at mathematics?

The next strategy is self-assessment. This involves activities where your goal is to reflect and monitor your own progress and determine your next steps in your learning. For example, when you compare your current work to past work or when you complete self-assessment quizzes.

- 7) When you participate in self-assessment activities, how does it make you feel? How does it affect your motivation? Does it make you feel that you are capable of doing well at mathematics?

The next strategy is peer assessment. This involves activities where your goal is to reflect on your peers' work, whether individual or group work, and provide feedback. For example, when your class does gallery walks.

- 8) When you participate in peer assessment activities, how does it make you feel? How does it affect your motivation? Does it make you feel that you are capable of doing well at mathematics?
- 9) Of all the strategies we have discussed, which do you believe makes you most motivated to learn mathematics?
- 10) Which strategy makes you feel that even if mathematics is difficult, you will be successful if you continue to try?

Appendix C

Teacher Interview Questions and Verbal Script

My name is Assuntina Del Gobbo and I am a Master of Education student at Brock University. Thank you very much for volunteering to participate in the interview for this study. I will be asking you a series of questions in order to get your feedback on the implementation of formative assessment strategies in your classroom and the impact on students' self-efficacy and motivation. Please provide examples and details as much as possible. I will be following up with some questions and prompting you to give examples, details, and clarifications whenever needed. Please feel free to ask me for any clarifications if you do not understand the question. Please note that the study results will be reported in ways that ensure complete confidentiality.

- 1) How long have you been teaching? What other classes or subjects do you teach?
- 2) Have you attended or offered any professional development on formative assessment? Who offered the professional development? Who was the audience?
- 3) How long have you been implementing formative assessment in your teaching?
- 4) Which formative assessment strategies do you implement in your teaching?
- 5) In what ways do you implement these formative assessment strategies in your classroom? Please provide examples. How often do you implement these strategies?
- 6) What are the challenges to implementing formative assessment in your math classes? What facilitates the implementation formative assessment in your math classes?
- 7) What do you think are the benefits of implementing these formative assessment strategies for students? For yourself?
- 8) Do you think all students benefit from the use of formative assessment? In what ways? Why or why not?
- 9) What do you believe is the impact of formative assessment strategies on students' motivation?
 - a. Is there any particular strategy that affects it more positively or negatively?
- 10) What do you believe is the impact of formative assessment strategies on students' self-efficacy?
 - a. Is there any particular strategy that affects it more positively or negatively?
- 11) Is there anything else you would like to share with me concerning your experiences implementing formative assessment?